SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MAY 1909.

GENERAL PHYSICS.

764. *Photographic Recording Apparatus.* **M. Edelmann, Jr.** (Phys. Zeitschr. 10. pp. 227–230, April 1, 1909. Communication from the physikal.-mechan. Inst. of M. T. Edelmann and Son, München.)—Describes a large photographic recording apparatus suitable for physical purposes. The instrument will take 75 m. of paper or film, and by means of speed pulleys the velocity of the paper can be varied from about 12 to about 8,000 mm. per sec., though, of course, practically any required speed could be obtained by the use of other pulleys. The paper passes behind a slit provided with a suitable cylindrical lens, in front of which is a glass plate with lines perpendicular to the length of the slit, which give a scale for the curve registered in any particular experiment. If necessary, several curves can be registered at once, as paper or film up to 12 cm. breadth can be used. For special features see diagrams in original paper. A. W.

765. *Pendulum.* **O. Krüger.** (Phys. Zeitschr. 10. pp. 225–227, April 1, 1909.)—Describes an experimental investigation of the variation of the period of oscillation of a pendulum with the acceleration. The pendulum used was suspended from a carriage attached to one side of an Atwood's machine, and the acceleration of this arrangement could be determined. The carriage was guided by four wheels running on two vertical steel wires, which were tightly stretched. The motion of the pendulum bob was registered on a vertical strip of paper as the pendulum fell or ascended. From this graph the ratio of the periods ascending and descending was calculated. With an acceleration of the falling carriage $\pm$ 25·5 cm./sec.^{2}, and taking g as 981 cm./sec.^{2}, the ratio $T_1^2/T_2^2 = 1{\cdot}058$. The mean experimental determination gave the value 1·055. A. W.

766. *Experimental Hydraulic Cylinder.* **E. G. Coker.** (Engineering, 87. pp. 871–872, March 19, 1909.)—This small cylinder, designed by the author for the City and Guilds Technical College, Finsbury, is about 12 ft. high and 2 ft. 6 in. diam. Heads up to 12 ft. are obtained from the main, up to 70 ft. from a roof tank, and up to 250 ft. from a pump. The tank is suspended from beams, and is fitted for vertical orifices at the sides, and horizontal orifices with vertical discharge from the flat bottom. The bottom orifice is closed by a concentric plate valve, and the side orifice by a rocking arm within the cylinder, both controlled by wormgear and hand-wheels. The article is illustrated with drawings and a photograph. F. R.

767. *Extension of Cracks in an Istropic Material.* **A. Mallock.** (Roy. Soc., Proc. Ser. A. 82. pp. 26–29, Feb. 16, 1909.)—It is assumed that if to a solid a strain is applied which exceeds either the limit of volume extension or the limit of shear, rupture will be due to that property for which the limit is least, and that if the distortion limit is the smaller, breakage will occur at right angles to the lines of greatest extension, whereas if the volume limit is least the direction of the break will be indeterminate. A solid body partly cracked through may be regarded as an infinite body with a given distribution of stress over a finite area—the remainder of the cross-section in the plane of the crack. It is then easily seen that strain and stress would be infinite at the bottom of the crack if the material did not yield. In most homogeneous solids the area over which the stresses exceed the mean at some distance from the bottom of crack will be of the same order as the square of the width of the crack, an area so small that the elastic and other limits within may be altered by surface-tension phenomena. In materials such as glass, rupture is probably due to reaching the distortion limit; but in materials in which fracture takes a wandering path, the dilatation limit has been exceeded. The same principles might be applied to explain the cleavage of crystals. F. R.

768. *Behaviour of Materials under Combined Stresses.* **J. E. Sears, Jr., L. B. Turner.** (Engineering, 87. pp. 258–259, Feb. 19, and p. 281, Feb. 26, 1909.)—Sears points out that a difference of 10 per cent. between the greatest and least tensions would arise through an eccentricity of 0·001 in. in tubes 0·02 in. thick, which is overlooked through an error by Turner [see Abstract No. 364 (1909)]. By a method of finding most probable instead of mean values, it is shown that the values of corresponding shear stresses are, from the tension tests 15,800 and from the pure torque tests 16,600 lbs. per sq. in., difference 5 per cent. Taking corresponding pairs of tests, however, the difference is 6½ per cent., the disagreement being due it is suggested to a weakening of the material in manufacture, as regards resistance to shear in planes at right angles to the axis. The simplest assumption for explaining this 6½ per cent. deviation from "Guest's law" (failure by max. shear) is the existence of an internal friction. Then there will be no yield if q is not greater than $q_0 + \mu p$, where q is the shear stress, q_0 the yield-point in pure shear, p the normal stress, and μ a constant. Turner applying this to his data obtains $q = 17{,}190 - 0{\cdot}067p$. F. R.

769. *Tests of Reinforced Concrete Beams.* **E. Brown.** (Eng. Record, 59. pp. 277–278, March 6, 1909. Extract from paper read before the Canadian Soc. of Civil Engineers.)—Gives results of tests of 1 : 2 : 4 trap concrete beams of 6 × 8 in. and 8 × 12 in. section, and 6 and 10 ft. span, reinforced with Kahn, Johnson, and Ransome bars. Five mirror extensometers were used. Some of the curves showing deformation measured at the various horizontal layers of the beam show slight concavity, but in nearly all cases the strain curve for the compression layers is practically a straight line. A simple analysis, in which the modulus of elasticity of the concrete is assumed constant, and concrete assumed to bear no share of the tensile force, shows that the ultimate moment of resistance of the beam is $Af_s(d - z)$, where

A is the sectional area of reinforcement, f_t the tensile stress in the steel, d the depth of beam to centre of reinforcement, and z the depth of centre of compressive forces below the extreme compression layer. It is shown that even if the distribution of compression strain departs notably from a straight line, the effect on z is slight, whereas considerable errors may arise in d in practice. For this reason, and also on account of the variability of modulus of elasticity of concrete and other factors, extreme refinement of analysis is useless. The centre of compressive stresses is at a distance $z = xd/3$ from the compression face; the moment of resistance of the steel is then $Af_td(1-x/3) = kAf_td$. k is found to have values from 0·82 to 0·88 in these tests, and is usually about 0·85. In the earlier stages of the test the tensile resistance of the concrete has an appreciable effect on the value of k. The positions of the neutral axes in similar beams were found to vary by as much as 9 per cent. of d, and roughly agree with values found by using 2×10^6 as the modulus of elasticity of the concrete in compression. Tests of cubes gave values from 2×10^6 to 3×10^6 lbs. per sq. in. for the modulus. Tests of beams and cubes which had been heated in a furnace to 1,250° F. are also mentioned. The beams failed at from 0·33 to 0·7 of the load required to break similar beams which had not been heated, and the neutral axis was from 0·6 to 1·6 in. above the centre of reinforcement. The modulus of elasticity of the roasted cubes was $0{\cdot}125 \times 10^6$, and their ultimate compressive strength 1,560 lbs. per sq. in.

F. R.

770. *Action of Sea Water on Cement Concrete.* **C. J. Potter.** (Soc. Chem. Ind., Journ. 28. pp. 6–10; Discussion p. 10, Jan. 15, 1909. Paper read before the Newcastle Section.)—As a result of trying various methods of overcoming the failure of Portland cement concrete by softening and expansion which occurs in a very few years or less in sea water, the author was successful when calcined red-brick clay was added to the clinker whilst grinding. 6 parts of clay to 10 of cement by weight give the best all-round results, and thorough mixing and fine grinding are necessary. A variety of test results extending over periods up to 10 years are given. For at least a few weeks after making, the "red" cement mortar is weaker than the Portland, but in the course of time the strength of Portland, kept in sea water, falls to zero, whilst that of the red is maintained or increases. As is known the failure of Portland is due to the presence of about 0·25 per cent. magnesium sulphate in sea water. Precipitated magnesia is found in the fracture of blocks of Portland cement concrete which have been exposed to sea water. The destructive action occurs rapidly in sea water to which has been added 10 per cent. of magnesium sulphate. In this solution neat Portland cement has a strength of 500 lbs. per sq. in. in one month, and *nil* after one year's immersion. Red cement gradually continues to gain strength, just as Portland cement does in fresh water. The greater the proportion of sand in the Portland cement mortar, the more rapid its failure in sea water, owing apparently to its greater porosity allowing more ready access of the solution. The strength of the red cement samples kept in sea water was rather higher than in fresh water. Some results of tests are also given which show that if Portland cement mortar be exposed for some time to the action of a CO_2 atmosphere before exposure to sea water, the action of the sea water upon it will not be so serious as if exposed to sea water immediately. Exposure to CO_2 of "red" cement mortar also increases its ultimate strength in sea water. The explanation suggested for the superiority of the red over the Portland cement is that a calcium silicate is formed which is not such a weak compound as those which usually occur in set cement, and hence is not decomposed by magnesium sulphate. F. R.

771. *Tensile Strength of Water.* **H. H. Dixon.** (Roy. Dublin Soc., Proc. 12. 7. pp. 60–65, April, 1909.)—Berthelot's experiments on the tensile strength of water (Ann. Chim. Phys., 1850) are cited and repeated. A strong capillary tube closed at one end and drawn out at the other is filled with water at 28° or 30°, the tube is cooled to 18° to allow a small quantity of air to enter, and when the open end of the tube is closed and the tube heated to 28° and gradually higher the enclosed air completely dissolves. On recooling to 18° the water still occupies the whole space within the tube. The pressure required to produce the same change in the density of the water as that noted was calculated by Berthelot at about 50 atmos. The author's experiments amply confirm the observations of Berthelot, and they raise the minor limit of the cohesion of water and of its adhesion to glass to over 150 atmos. It is evident that such a tensile strength is more than sufficient to withstand the stresses developed in lifting the transpiration stream in plants and in overcoming the resistance of the conducting tracts. G. E. A.

772. *Transverse Vibrations of a Square Plate with Free Edges.* **W. Ritz.** (Ann. d. Physik, 28. 4. pp. 737–786, March 16, 1909.)—A new method of integration is developed for a square plate with free edges, which can also be applied to rectangular plates with free, partially free, or wholly supported edges; the method is founded on the principle of least action. The frequencies of the tones of the plate are roughly expressed by—

$$N = A\sqrt{[m^4 + n^4 + 2(1-\mu)m^2n^2]},$$

where m and n are whole numbers, and A and μ are constants of the plate. The frequencies calculated for 35 overtones agree with those given by Chladni within the expected error; 46 Chladni figures are given. G. E. A.

773. *Climate of Lourenço Marques, Mozambique.* **P. Berthoud.** (Boletin de la Socid. de Geographie, Nov., 1908. Extract by **J. Hann** in Meteorolog. Zeitschr. 26. pp. 136–137, March, 1909.)—The climate is pleasant from June to Aug. and Sept., but very unhealthy in Jan. to March. The soil surface heats up to 78° in the hot season, but sudden drops in temperature are frequent; 47° has been observed in the shade; in the winter the thermometer may go down to 6·5° Very great psychrometer differences have been noticed. Mosquitoes are found all the year round; they come with N. wind and disappear with S. wind. The 717 mm. of rain generally comes in heavy downpours. There are 66 days with at least 0·1 mm. of rain in the course of a year. The winds are brisk, but never of excessive force. H. B.

774. *Estimation of the Amount of Cloud.* **A. S. Steen.** (Meteorolog. Zeitschr. 26. pp. 49–54, Feb., 1909.)—The object of the paper is to find a numerical value for the uncertainty introduced by the absence of illumination in the estimation of the amount of cloud as ordinarily made at climatological stations. The author has examined the hourly observations of the amount of cloud available for 8 observatories. If W_p stand for the mean amount of cloud for epoch p, then $\Delta = W_{p+1} - W_p$ is the mean variation from hour to hour. The values of Δ were calculated for each hour for each month for all 8 observatories, and the hours of sunset and sunrise corresponding with the middle day of each month were then noted on the

tables. In the subsequent work the day and night hours were treated separately. The greatest positive and the greatest negative values of Δ were picked out from each group; their arithmetic sum, which is called the variation amplitude, gives an expression for the mean variability of the amount of cloud. The results show: (1) that the variations are greater by night than by day at all times of the year; (2) that the variation amplitude by day has a perfectly regular annual variation; (3) that the variation amplitude by night is very irregular; in summer it has a minimum at those stations where twilight renders the night light. The author concludes that the irregularities in the variation amplitude by night are due to difficulties in making satisfactory observations in the absence of illumination, and suggests that attempts to determine the annual variation in the amount of cloud from climatological observations at fixed hours which are made partly by day and partly by night, are open to considerable doubt.

R. G. K. L.

775. *Cloud Heights determined by means of Searchlights.* **J. Rheden.** (Meteorolog. Zeitschr. 26. pp. 60-66, Feb., 1909.)—Observations of the height of clouds made by directing a searchlight vertically upwards and determining the angular elevation of the illuminated patch of sky from a fixed base station were continued at the astronomical observatory at Vienna during the summer of 1908. Tables giving the results of observations for 50 evenings are given in the paper. The results show that media capable of reflecting light were frequently found to exist at heights greater than 10 km. The column of light could be traced up to an altitude of 17·1 km. on May 31 and to 16 km. on July 27. The greatest cloud height (Ci.-Str.) was observed at 8 km. The height of the dust or smoke layer over the city was fixed on two occasions at 300 m. and 120 m. respectively. Confirmatory observations were made occasionally from a second station distant 8·3 km. from the source of light; the agreement is only a moderately good one.

R. G. K. L.

776. *The Isothermal Layer of the Atmosphere and Atmospheric Radiation.* **E. Gold.** (Roy. Soc., Proc. Ser. A. 82. pp. 43-70, Feb. 16, 1909.)—In an atmosphere which radiates and absorbs there will be a theoretical distribution of temperature in which there is equilibrium between the radiation and absorption of each element. If the vertical temperature gradient in this state be less than the adiabatic, the effect of a direct communication of heat to the atmosphere at the earth's surface will be to set up convection currents, and a state of convective equilibrium will supervene but only up to a height sufficiently great for the increased radiation, due to increase of temperature, to balance the energy supplied. In the upper part of the convective system the radiation from any horizontal layer will exceed the absorption and so tend to restore the state of radiation equilibrium. After stating the assumptions regarding the radiating power of the atmosphere on which the paper is based, and briefly reviewing the available experimental data on the radiation and absorption of gases, the author proceeds to develop mathematical expressions for the intensity of solar, terrestrial, and atmospheric radiation at any point in the atmosphere, the latter being divided into the two parts received respectively from the atmospheres above and below the given level; and for the absorption and emission by any horizontal layer of finite thickness. The conditions for convection to be possible and for thermal equilibrium in the absence of convection are also found. The equations thus obtained lead to the following results. (1) In an atmosphere of uniform constitution, in which the absorption by a layer of given mass would be the same at all levels, the adiabatic state could not extend to a height greater than that for which $p = p_0/2$, where p_0 is the surface pressure. If such an atmosphere were isothermal, the absorption of solar radiation in any layer of it, beginning from $p = 0$ would be equal to the absorption of terrestrial and atmospheric radiation, and each would be equal to the radiation in either direction from the layer. (2) In the earth's actual atmosphere the constitution is not constant with altitude, owing to changes in the amount of aqueous vapour. The radiating power may be represented by $a/(q - p)$, where a and q are constants and p is the pressure. Adopting values of a and q in accordance with the experimental results, it is found that if the atmosphere consist of two shells, the inner in the adiabatic, the outer in the isothermal state, (i.) the inner cannot extend to a height greater than that for which $p = p_0/4$ (10,500 m.); (ii.) the inner must extend to a height greater than that for which $p = p_0/2$ (5,500 m.). (3) It is shown that the radiation from the lower layers of the atmosphere exceeds the absorption by them, and that the deficiency of energy is such that it could be supplied by convection from the earth's surface or by the condensation of water-vapour. The deficiency for the layer $p_0/2$ to $p_0/4$ is practically negligible, indicating that convection above $p_0/2$ will be very slight. (4) Minimum possible temperatures for any point in the atmosphere above a place at 300° (abs.) are 150° or 200° abs., according as the atmosphere radiates throughout the spectrum or only for a part of it containing 75 per cent. of the energy of full radiation for its temperature. The values are deduced from what would be the radiation intensity across the upper strata of the atmosphere, supposing it were maintained in the adiabatic state throughout, for this radiation must correspond with a temperature which is less than that for any other possible temperature distribution when the surface temperature is unchanged. R. G. K. L.

777. *The Sea Water near Concarneau.* **R. Legendre.** (Comptes Rendus, 148. pp. 668–670, March 8, 1909.)—In the shore water near Concarneau, France, Dept. Finistère, the max. temperature is observed between 2 and 5 p.m., the minimum a little before sunrise. The tides alter these hours because the shore water is warmer than the sea water. In the estuary of the Moro River the tides have a similar effect, bringing the max. temperature earlier with spring tides and delaying it with neap tides. The fluctuations in the density of the water are less regular, being influenced by sunshine, currents, rain, &c. The amount of oxygen contained in the water has its maximum about 2 or 4 p.m., and its minimum a little before sunrise; sunshine accentuates the differences, the motion of the sea and the tides have little influence. On the whole the oxygenation goes together with insolation and temperature changes, and is probably dependent on the chlorophyl assimilation of the algæ and, further, on the vital processes of other organisms. During the night the oxygen content sinks below the amount that water can keep in solution; during daytime it rises to 12 and 14 mgm. per litre, and thus above the amount which water normally keeps in solution. This peculiarity is not explained so far. The author's observations concern only the summer, and are to be continued. H. B.

778. *Seismic Frequency and Isobar Gradient.* **T. Terada.** (Mathematico-Physical Soc., Tōkyō, Proc. 4. 22. pp. 454–459, Dec., 1908.)—The author refers

to the results of Omori, who found remarkable parallelism between earthquakes and barometric variations, and C. G. Knott, who drew attention to the influence of isobar *gradient* as producing the shearing stress evidenced by earthquake phenomena. He then proceeds to an analytical discussion of the isobaric gradient for certain districts deduced from four stations to each, and determines the variation diagrams for them. The curves are very similar to Lissajou's figures. On comparing these with the times of occurrence of numerous large earthquakes in Japan, it is shown that these appear to be clustered about the epochs when the variation curves indicated turning-points. C. P. B.

779. *Earth's Precessional Nutation and Tidal Deformation.* **J. Larmor.** (Roy. Soc., Proc. Ser. A. 82. pp. 89–96, Feb. 16, 1909. Roy. Astronom. Soc., Monthly Notices, 69. pp. 480–486, April, 1909.)—Kelvin estimated that existing shifts of material, due chiefly to meteorological causes, are competent to produce displacements of the axis of rotation ranging from 0·5 to 0·05 second of arc. Also as the motion of the pole is damped off by frictional effects of tides, &c., it is renewed by fresh rearrangements of terrestrial material. From the various discussions with the data thus supplied the earth's rigidity has been computed to lie within the limits 17×10^{11} and 4×10^{11}, and it appears as if the free precession of the yielding earth is the same as that of a rigid one of the shape that would result when the bulging due to the centrifugal force of diurnal rotation is removed. The present paper goes on to show that this result may be regarded as general, and extends to an earth of any degree of heterogeneity or plasticity. Reference is made to the effect of seismic disturbances, those of submarine origin being considered of greatest effect in their disturbance of the poles. C. P. B.

780. *Records of the Earthquakes of December* 28, 1908, *and January* 23, 1909, *at Athens.* **D. Eginitis.** (Comptes Rendus, 148. pp. 739–740, March 15, 1909.)—The Messina earthquake of Dec. 28 was recorded at Athens by the vertical pendulum instrument, 7·25 m. in length, weighing 200 kg.; the principal phase set in 6 sec. later on the N.W.-S.E. component than on the N.E.-S.W. component. The preliminary phases could not be distinguished, indicating that the source of the disturbance was near by. In the earthquake of Jan. 23 the two preliminary phases were distinct on both components, and according to Laska's formula the distance of the epicentre was about 3,000 km. H. B.

781. *Earthquake of January* 23, 1909. **A. Angot.** (Comptes Rendus, 148. pp. 251–252, Jan. 25, 1909.)—Details of trace registered at Parc St. Maur, with the Milne seismograph, showing that the movements began at 2h. 56·7m. (G.M.T.), and the large waves at 3h. 6·2 m., with a maximum at 3h. 12·0m. of 15 mm. (1 mm. on trace corresponds to an inclination of 0″·48). C. P. B.

782. *Solar Work at Mount Wilson, California.* **G. E. Hale.** (Science, 29. pp. 220–222, Feb. 5, 1909.)—Monochromatic photographs of the sun have been made daily on Mount Wilson since Oct., 1905, with the Snow telescope and 5-ft. spectroheliograph, chiefly in calcium, hydrogen and iron radiation. Prior to March, 1908, hydrogen photographs were taken in Hδ light; since that date Hα light has been used with special red sensitive plates. These latter plates revealed evidence of vortices surrounding the sun-spots. The phenomena of the Zeeman-effect due to magnetic fields have been unmistakably detected in the spectra of spots, the strength of field amounting to 2,800–4,500 gauss in different spots. Vortices rotating in opposite directions

show opposite polarities, the changes in the spectrum and in the polarisation phenomena being precisely similar to those of a luminous source in a magnetic field when the current through the magnet is reversed, indicating that the magnetic field is produced by the revolution of negative corpuscles. C. P. B.

783. *Solar Vortices.* **A. Brester, Jr.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 592–599, Feb. 25, 1909.)—Hale has recently formulated the case for believing solar spots to be vortices, continually absorbing hydrogen, which is again poured outward during formation of new prominences on flocculi outside the spots [Abstract No. 1586 (1908)]. The author considers this contradictory to the other work of Hale where the angular velocity of the hydrogen flocculi in every latitude was practically constant. Moreover, many careful observers have definitely stated that no evidence of rotation in spots is to be detected, and Hale and Adams find little or no indication of motion in the spot vapours. It is then suggested that the sun is radio-active, and that the β-and γ-rays emitted through a spot nucleus, impinging on the solar outer atmosphere, cause the phenomena observed. C. P. B.

784. *Level of Sun-spots.* **A. W. Dobbie.** (Nature, 80. p. 19, March 4, 1909.)—From photographs taken at Adelaide during the solar eclipse of 1905, stereograms have been prepared which show the two groups of spots then on the disc to be at different levels. The photographs were taken with an 18-in. Newtonian reflector of 18 ft. focal length, stopped down to an aperture of 4·5 in. Exposures of about $\frac{1}{1000}$ sec. duration, with an interval of $2\frac{1}{4}$ hours. C. P. B.

785. *Large Solar Prominences.* **S. Chevalier.** (Memorie della Società degli Spettroscopisti Italiani, 38. No. 2. Nature, 80. p. 108, March 25, 1909. Abstract.)—Description of two remarkable prominences observed at Zô-Sé Observatory, China, on July 30 and 31, 1908. Lines of helium and hydrogen were brightly reversed, and in addition there was the strange feature of a strong continuous spectrum, which practically obliterated the atmospheric spectrum adjoining. This had also been noticed previously by Young on Aug. 8, 1872; it is attributed to heated solid particles condensed from the metallic vapours carried up by the rush of gases. C. P. B.

786. *Comparative Spectra of Sun and Electric Arc.* **C. Fabry** and **H. Buisson.** (Comptes Rendus, 148. pp. 688–690, March 15, 1909.)—In general the wave-lengths of spectral lines increase with the pressure in the medium in which they are produced. The solar and metallic spectra have been examined with the photographic interferometer between $\lambda 4000$ and $\lambda 4500$, and visually about $\lambda 5100$. The displacements vary greatly for different lines, and it is thought that variations of pressure are alone unable to account for the effect observed. The general conclusion from the consistent lines is that the pressure in the solar reversing-layer may be about 5 or 6 times the terrestrial atmospheric pressure. C. P. B.

787. *Some Photographic Images of Mars taken in* 1907 *by Lowell.* **E. M. Antoniadi.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 110–114, Dec., 1908.)—Notes on a print showing 40 images of Mars taken on July 11, 1907, when the longitude of the centre of the disc was about 250°. The 40 images differ widely in the amount of detail recorded, and also the same markings

presents themselves under varying forms, owing probably to atmospheric tremors. The superior brightness of the limb, so striking a feature in visual observations, is non-existent on the photographs. Schiaparelli depicted the *Maria* as bordered by darker canals whenever the markings were seen to double, but no trace of such a structure is shown. In accordance with Schiaparelli's map, the part of the South hemisphere between the *Maria* and polar cap is dusky. The "islands" in this expanse is known to be ruddy. Seven "lakes" are shown, and 17 "canals" are more or less discernible, corresponding, with one exception, to canals of Schiaparelli. All these canals are diffuse. Comparison of the photographs with Schiaparelli's observations furnishes strong evidence of change in the form and intensity of the dusky areas. For instance, *Syrtis Major* had always the form of a regular V to Schiaparelli, but in the photographs it shows a distinct bulge to the north-east. A reproduction of a composite drawing made by the writer from the prints accompanies the paper. A. E.

788. *Martian Features.* **Lowell.** (Lowell Observatory, Bull. No. 84. Nature, 79. p. 878, Jan. 28, 1909. Abstract.)—The Bulletin describes, and gives positions of, eight white spots observed in the arctic and sub-arctic zones of Mars by Flagstaff observers, and which appear year after year in the same places. The chief spot appears in long. 206°, lat. 88° N., and was first observed by Schiaparelli in 1884; in 1908 at Flagstaff it was observed from June 21 to Aug. 10, Martian dates, being seen at every one of the six presentations. A. E.

789. *Contribution to the Search for Planets beyond Neptune.* **A. Gaillot.** (Comptes Rendus, 148. pp. 754–758, March 22, 1909.)—The observations of Neptune cover only a very small portion of an entire revolution, and it therefore appears premature to base upon them the search for a planet more distant from the sun. Lau, Forbes, and W. H. Pickering have recently attempted to determine the position of this hypothetical planet, and have obtained results which are quite discordant. The author has therefore endeavoured to throw some additional light upon the question by an examination of the observations of Uranus, which, besides some 40 observations made between 1690 and 1771, comprise a regular series from 1781 to the present time. Three hypotheses were made successively relative to the distance a of the unknown planet from the sun, namely, $a = 44$, $a = 46$, and $a = 48$, its mass to begin with being assumed as 1/20000 of the sun's mass. In investigating the effect which such a hypothetical object should have upon the motion of Uranus, certain indications arose pointing to the possibility of another, and still more distant planet, also exercising a perturbing influence. The final results give rise to the conclusion that the possible existence is admissible of two ultra-neptunian planets, one at a distance from the sun equal to 44 times the earth's mean distance, and having a mass about 1/64000 of the sun's mass; the other at a distance of 66, and having a mass about 1/14000 that of the sun. In 1850 the longitude of the first planet would have been 209°·3; that of the second 74°·1. In 1910 the longitude of the first would be 284°·2; that of the second 114°·6. Assuming the inclinations of the orbits to be small, in 1910 the position of the first would be R.A. = 19h. 0m., Dec. = − 22°·7, and of the second R.A. = 7h. 48m., Dec. = + 21°·8. The results, however, are presented with extreme reserve, and are merely to be taken as indicating the regions of the sky where search may have the best chance of success. The position here given for the first planet agrees within a degree or two with that found

by Lau from documents relating to Newcomb's theory of the motion of Uranus. In 1900 the author's value for the longitude would be 271°, Lau's 269°. On the other hand, the difference for the second planet is large, 108° as against 158°. But, by a curious coincidence, the author's position for this second planet agrees with W. H. Pickering's, R.A. = 7h. 47m., Dec. = + 21°. The method by which Pickering attained this result, and also the distance from the sun at which he places the planet, are unknown to the author. As regards the position assigned by Forbes to a planet beyond Neptune, $a = 105°$, longitude in the orbit = 215° in 1908, no conclusion either for or against can be drawn from the present work, since a planet at such a distance could produce no appreciable perturbation in the motion of Uranus. To complete the investigation, an attempt was made to examine what influence planets having the masses and positions indicated above would exercise upon the motion of Neptune. The negative nature of the results confirms the prediction that observations of Neptune will not be of practical service in the search for a more distant planet. A. E.

790. *Water-vapour in Atmosphere of Mars.* **F. W. Very.** (Science, 29. pp. 191–198, Jan. 29, 1909. Lowell Observatory, Bull., No. 36. Nature, 79. p. 499, Feb. 25, 1909. Abstract.)—The first observations of the intensification of water-vapour bands in the spectrum of Mars were made by Huggins in 1867, and were confirmed by Vogel in 1873. Later the Lick observers questioned the reality of the phenomenon, but the recent photographic confirmation by V. M. Slipher at the Lowell Observatory has put the matter on a much more certain basis. From information supplied by Lowell the present author has been enabled to estimate the quantitative degree of intensification of the *a* band on which the determination is based. The instrument used is called the spectral-band comparator, and compared with the moon as unity the *a* band in Mars has an intensity of 1·224, but this requires standardisation for the readings of the comparator before absolute units can be stated. When this is allowed for, it is found that the *a* water-vapour band in the spectrum of Mars during Jan., at Flagstaff, with the dew-point at 20° F., was 4·5 times as intense as in the lunar spectrum at the same altitude. This would correspond to about 5·0 gm. of water-vapour per $m.^3$ if we assume terrestrial conditions. Owing, however, to the comparatively rare atmosphere of Mars, to the low boiling-point of water there, and to the prevailing desert conditions, the dew-point at the surface will remain low, probably seldom rising much above the freezing-point, and the prevailing conditions on Mars are probably those of a mild but desert climate. C. P. B.

791. *Spectrum of Mars.* **W. W. Campbell.** (Science, 29. p. 500, March 26, 1909.)—The author considers that Very's article [see preceeding Abstract] may convey a wrong impression concerning the early observations of the spectrum of Mars. The pioneer observers believed they saw in the spectrum of Mars evidence of the modifying influences of oxygen and water-vapour in its atmosphere, but other work of similar nature led to doubt as to the spectroscopic evidence. In those days the spectrum could not be observed beyond λ6900, and it is only by means of the newly discovered sensitisers for photographic plates that determinations of the *a* water-vapour band at λ7175 have been possible. As Very's discussion was entirely based on the intensity of this band, the question of the correctness of the older observations is not involved. It is pointed out that Slipher's photographs show no traces of absorption of oxygen or water-vapour, in the region λ5400–6900, and thus confirm Campbell's observations of 1894–5. C. P. B.

792. *Luminous Meteor Cloud.* **C. J. Kullmer.** (Monthly Weather Rev., Washington, 86. p. 410, Dec., 1908.)—Continued observations of meteor trails promise to furnish important information respecting the movements of the upper clouds. This is illustrated by the case of a brilliant meteor seen at Urbane, Ill., on Nov. 14, 1904, when the observations of the resulting luminous matter were obtained at intervals of some minutes. C. P. B.

793. *Comparative Activities of the Leonids and Geminids Meteor Streams on November* 14, 1907. **M. Farman** and **E. Touchet.** (Comptes Rendus, 148. pp. 264–266, Feb. 1, 1909.)—On the night 18–14 Nov., 1907, which was clear, 25 shooting stars were observed at Chevreuse. The prolongations of the trajectories were traced by Chrétien's graphic method, and of the 25 meteors, 4 were found to come from a radiant in Leo, 4 from a radiant in Lacerta, and 11 from a radiant in Gemini, the remaining 6 being classed as sporadic. The preponderance of Geminids is a remarkable feature not observed in previous years. The precise position of the radiant in Gemini, calculated by Bolin's formulæ, is 115°, +26°, or 2° below β Geminorum. The radiant at β Geminorum (xciv. Denning) begins to be active in Oct., attaining a maximum 9–12 Dec. at the time of the Geminids shower. A. E.

794. *Radial Velocity of α Persei.* **F. Goos.** (Astronom. Nachr., No. 4800. p. 50, 1909. Nature, 80. p. 51, March 11, 1909. Abstract.)—From a series of 87 spectrograms of α Persei obtained by Küstner and Zurhellen the author has derived values of the radial velocity during the period Aug., 1904–March, 1906, the results indicating a variation from −8·65 km. to 0 km. per sec. C. P. B.

795. *The Diminution of Light in its Passage through Interstellar Space.* **H. H. Turner.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 61–71, Nov., 1908.)—The hypothesis of scattering of light by small particles in space [see Abstract No. 625 (1909)] will explain the following facts: (*a*) The ratios of the number of stars per magnitude tabulated by Kapteyn as far as the twelfth magnitude. (*b*) The fact that when photographic exposure is prolonged in a ratio which ought to give stars fainter by five magnitudes, only four visual magnitudes are obtained. The scattering of light should be greater for photographic than for visual rays, according to Rayleigh's law of λ^{-4}. (*c*) The ratios of the counts of stars for different exposures found at Greenwich. (*d*) The smallness of the total light of all the stars. Evidence is given in support of these statements, and one or two further observational tests are proposed. The anomalous results of increased photographic exposure should tend to disappear when photographs are taken in yellow light. The coefficient corresponding to one step in magnitude is about 0·30 for visual, and 0·60 for photographic magnitude. The fact is pointed out that the value for the total light of all the stars derived from the later portions of Kapteyn's lists is in excess of Newcomb's observed value. A. E.

796. *Analysis of the Colours and Magnitudes of* 3,680 *Stars between the North Pole and* 25° *S. Declination.* **W. S. Franks.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 106–107, Dec., 1908.)—The analysis of the colours and magnitudes of stars has been performed as a sequel to a recent investigation of star colours and spectra [see Abstracts Nos. 214, 1927 (1908)]. The magnitudes are based on the Revised Harvard Photometry and the minimum limit is taken at 6·5. The *comites* of double stars are excluded. The stars are

divided into seven colour-groups ranging from white, through deepening shades of yellow and orange, to red. The ultimate results of the work are exhibited in two tables, showing, for galactic and non-galactic regions respectively, the number of stars of each colour for each of the first six stellar magnitudes. In a third table the results are combined. It is found that the relative distribution of colours is not the same in galactic and non-galactic regions, but that there is a great excess of white stars in the galaxy, and a decided preponderance of coloured stars in the non-galactic regions. There thus appears to be a physical connection between the colours of the stars and the galaxy, a region associated with nearly all the active sidereal phenomena, *e.g.*, helium stars, Wolf-Rayet stars, bright-line spectra, short-period variables, novæ, &c. A.E.

797. *Spectra of Nebulæ.* **M. Wolf.** (Astronom. Nachr., No. 4305. p. 151, Feb. 16, 1909. Nature, 80. p. 19, March 4, 1909. Abstract.)—Working at Heidelberg Observatory, the author has photographed the spectra of several nebulæ with the Waltz reflector.

N.G.C. 6210.—Ten lines of spectrum photographed; 469 not recorded; $H\gamma$ double. *Ring nebula in Lyra.*—Seven chief lines; $H\alpha$ registered. *Nebulæ near galactic poles.*—Show continuous spectra with maxima, but the condensations too weak to measure. C. P. B.

REFERENCES.

798. *Pressure of Sand on the Bottom of a Box.* **F. Kötter.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 16. pp. 493–510, 1909.)—A mathematical treatment for the pressure on a portion of the horizontal bottom of a box of sand, taking into account the effects of the sides. F. R.

799. *Properties of Matter.* **J. J. Thomson.** (Engineering, 87. pp. 326–327, March 5; 360–361, March 12; 391–392, March 19; 429–430, March 26; 460–461, April 2, and pp. 496–497, April 9, 1909. Lectures delivered at the Royal Institution. Electrician, 62. pp. 875–876, March 19, and pp. 997–999, April 9, 1909. Abstract.)

800. *Theory of Surface Forces.* **G. Bakker.** (Phil. Mag. 17. pp. 333–355, March, 1909.)—A continuation of the author's previous work [see Abstracts Nos. 209, 2015 (1907), and 745 (1908)].—Applications are made to the size of water-drops in "haze." A. W.

801. *Sicilian Earthquake of December* 28, 1908. **B. Galitzin [Golycin].** (Acad. Sci. St. Pétersbourg, Bull. No. 4. pp. 279–298, March 1, 1909.)—Analysis of the various phases of the seismographic records obtained at the Pulkowa Station, with reproductions of the traces obtained. C. P. B.

802. *Rotation of Sun during* 1908. **W. S. Adams.** (Astrophys. Journ. 29. pp. 110–145, March, 1909.)—Previous papers have dealt with variations of rotation deduced from certain selected lines of the spectrum [Abstracts Nos. 207, 1051 (1908)], showing that different lines showed different velocities. The present paper consists partly of a continuation of the general investigation, and also of a special study of the lines of certain elements known to rise to great altitudes in the solar atmosphere. C. P. B.

803. *Ultra-violet Region of Solar Spectrum.* **A. Miethe** and **E. Lehmann.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 8. pp. 268–277, 1909.)—Photographs of the ultra-violet part of solar spectrum at different altitudes, showing limit of atmospheric absorption. C. P. B.

LIGHT.

804. *Mercury Paraboloid as Reflecting Telescope.* **R. W. Wood.** (Astrophys. Journ. 29. pp. 164–176, March, 1909.)—Description of the making and preliminary tests of a rotating paraboloid mercury surface for use as a reflecting telescope. Vibration was eliminated by using a magnetic field rotor, and photographs are given showing very fair star images. Reflectors up to 20 in. in diam. have been successfully employed. It is proposed to take casts of the surface in rotation by some material which after using will retain the form of the paraboloid. C. P. B.

805. *Uniformity in Spectroscopy for Photographic Purposes, and a Proposed Form of Instrument.* **C. Jones.** (Photographic Journ. 49. pp. 110–115; Discussion, pp. 115–119, Feb., 1909.)—The author puts forward a design of a simple spectrograph for general use. A transmission grating, two glass achromats of 8 in. focus and four slits of fixed widths cut in a sliding plate form the essentials of the instrument. Quarter-plates are used, and seven photographs can be taken upon each. E. C. C. B.

806. *Apparatus for Varying the Illumination of a Surface according to a Predetermined Law.* **T. Guilloz.** (Comptes Rendus, 148. pp. 164–167, Jan. 18, 1909.)—Describes an optical arrangement for varying the illumination of a surface according to a given law of intensity. The arrangement consists in taking as a luminous object a rectilinear source of light (*ab*), of uniform intrinsic brightness, perpendicular to the direction of the axis of a cylindrical lens before which is placed a diaphragm whose curvature corresponds to the function $y = f(x)$. The image of *ab* is a rectangle, and it is shown that the illumination, uniform horizontally, follows vertically the law of variation $E = f(x)$; the relation between x and X is given by the equations $x/X = p/p'$ and $1/p + 1/p' = D$, where D is the dioptric power of the lens. If the diaphragm is triangular, the vertical illumination varies proportionately to the distance from the origin. A. W.

807. *Photographic Shutters.* **E. A. Salt.** (Photographic Journ. 49. pp. 170–188; Discussion, pp. 188–185, March, 1909.)—General *résumé* of the subject and comparison of shutters. A new shutter-meter is described, with dry plate rotating in the path of the rays of light, the image of a slit lengthening and the circular aggregate image therefore widening as the shutter opens, and *vice versâ.* Another method for recording the passage of a blast of air blown through the shutter is mentioned. A. D.

808. *New Projection Screen with Metallic Surface.* **H. Lehmann.** (Deutsch. Phys. Gesell., Verh. 11. 5. pp. 128–136, March 15, 1909. Paper read before the 80. Naturforscherversamml., Cöln., Sept. 22, 1908. Phys. Zeitschr. 10. pp. 272–278; Discussion, pp. 278–279, April 15, 1909.)—For the projection of feebly illuminated pictures, such as those of opaque objects or colour photographs, a screen which makes use of metallic reflection offers a much better medium than the usual linen sheet. Differently prepared diffuse-reflecting metallic surfaces are examined photometrically and the results shown in the form of curves. The screens of most importance in practice are those with surfaces covered with aluminium powder. A "smooth aluminium" is well adapted for the projection of polarisation phenomena, spectra, &c., being twelve times as bright as the ordinary screen. Such screens should be resorted to only when the illumination lies well under 50 Hefner candle-metres. G. E. A.

809. *A Detector of Ultra-violet Rays.* **C. Schall.** (Photograph. Wochenblatt, p. 88, 1907. Scientific American, 98. p. 298, April 25, 1908.)—A photochemical method of detecting the presence of ultra-violet rays is described, based upon the fact that these rays alone produce a blue colouration on paper saturated with *p*-phenylene diamine solution. Diffused daylight only gives the paper a pale grey tint, but an instant's exposure to a quartz mercury lamp produces the blue colour. A thick plate of ordinary glass acts as a screen to the rays. The paper is prepared by floating it on a solution of 1 part by weight of *p*-phenylene diamine in 14 parts of water and 4 parts of a 40 per cent. solution of nitric acid. The paper should be dried by application of heat and used immediately. L. H. W.

810. *The Short-base Range-finder.* **H. D. Taylor.** (Engineering, 86. pp. 639–640, Nov. 13; 707–708, Nov. 27; 783–784, Dec. 11, 1908, and 87. pp. 140–141, Jan. 29, 1909.)—A series of papers on the above subject. The first three are concerned with the range-finder of Barr and Stroud; the fourth deals in particular with the Cooke naval range-finder, of which the construction is explained by means of diagrams and a photo. In this type of instrument the rays entering at one end traverse the whole length of the tube, and are passed by means of reflectors half-way along the tube again, travelling alongside of the rays which enter at the other end. At the middle of the tube both sets of rays are reflected into the eyepiece, and the horizontal separation of the two images is neutralised by the motion of a "swinging" prism of small angle set in the position of minimum deviation. The device of neutralising and measuring the parallax by rotating a prism away from its position of minimum deviation about an axis parallel to its refracting edge is claimed to be the most delicate and unerring method yet devised. The ivory scale giving the ranges is about 30 in. long and is seen and read in the upper part of the field of the finder telescope which carries a small pointer. For other details of construction the paper itself should be consulted. No particulars are given as to the range and accuracy of the instrument. G. E. A.

811. *Diffraction Phenomena and Theory of Diffraction.* **A. Schulze [Šulice].** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 40. No. 7. pp. 307–321 [Physical Part], 1908.)—When a squared grating, arranged in a camera with a square aperture the sides of which are parallel to the lines of the grating, is gradually moved away from the illuminated surface (sensitive plate), the portions of this surface which were dark when the grating was close to it gradually lose their sharpness until ultimately the whole surface becomes uniformly illuminated. If now the width of the lines of the grating and their distance apart be changed, the same result is obtained, provided that the relation $K : B = A : R$ is fulfilled, where K is the distance of the aperture from the sensitive plate, B the length of side of the aperture, A the distance of the grating from the plate, and R the constant of the grating which is equal to the sum of L, the breadth of the grating lines, and Z the distance between these lines. The results obtained are opposed to the view generally accepted, that diffraction is most apparent when the light passes through a narrow aperture

and that, when a large aperture is used, diffraction effects are exhibited only in very minute amount and only at the outer limits of the body. The uniform illumination of the surface above mentioned is due to the coincidence of the light minima and maxima. It is supposed, from the above results, that light which has not passed through a diaphragm, such as light from a cloud-covered sky, should, owing to diffraction, deviate from its course at the borders of any body. These views are expanded, and the author illustrates his results by means of photographs. **A. Geršun.** (Ibid. 40. No. 8. pp. 363–365 [Physical Part], 1908.)—Geršun discusses certain of Šulice's results, of which he gives a simple explanation. T. H. P.

812. *Increase in Sharpness of Interference Bands.* **O. v. Baeyer.** (Deutsch. Phys. Gesell., Verh. 11. 5. pp. 118–122, March 15, 1909. Physikal. Inst. d. Univ., Berlin.)—When interference bands are formed by means of a plane-parallel glass plate, if a medium of somewhat higher refractive index than that of air replaces the air on one side of the plate, the angle of incidence can be so chosen that the rays at the boundary glass-air are totally reflected, but are capable of passing through at the other side of the plate. By this means the whole light-intensity may be brought to one side and a notable increase in the brightness and sharpness of the bands obtained. A glass plate, 8·2 mm. thick, was fixed gas-tight on the top of a small metal box, into which ether-vapour was introduced gradually by means of a wick, and interference bands, formed from the green mercury line 546 $\mu\mu$, were photographed. These bands were very clear and sharp, the smallest intervals between the components separable on the photographic plate being 0·03 Å.U. G. E. A.

813. *Anomalous Dispersion of Light in Metallic Vapours.* **H. Geisler.** (Zeitschr. wiss. Phot. 7. pp. 89–112, March, 1909.)—An investigation of the anomalous dispersion in metallic vapours by means of interference fringes. The fringes were produced with a Jamin refractometer and a 1-m. focus concave grating. The apparatus was so arranged that the fringes were horizontal, that is to say, at right angles to the spectrum lines. The metallic vapours were all obtained with an arc, and the following were examined: the alkali and alkaline earth metals, Cu, Ag, Mg, Zn, Cd, Al, Tl, Bi, Cr, Mo, Mn, Fe, Co, Ni, Er, Ce, and also CaF_2. The results obtained were all in agreement with theory, the fringes being curved in the same direction in each case. Anomalous dispersion was also noted with certain bands, only the bending of the fringes was different from that observed with the lines. On approaching the head of a band the fringes were curved just as in the case of a line, but on the other side of the head the fringes, as the tail of the band is passed, slowly regained their original positions. There was thus no discontinuity, but the author points out that this is probably only a summation effect of all the lines in the band. E. C. C. B.

814. *Double Refraction in Metallic Films.* **H. Rumpelt.** (Ann. d. Physik, 28. 3. pp. 621–650, March 2, 1909. Abbreviated Inaug. Dissertation.)—When electrolytically deposited films of Pt, Au, Ag, and Ni are stretched within their elastic limits their optical constants experience no change such as can be measured by the reflection method. But as the double refraction observed by Kundt in mirrors formed by kathodic pulverisation and by Kaempf in the stretching of a Pt mirror lies within the limits of observation of the above method, these effects cannot be considered as a

consequence of the mechanical deformation. A formula for calculating the double refraction from the state of vibration of the light transmitted normally through the doubly refracting layer is given, and the phase-difference and amplitude relation of the incident light is measured for different colours with Ag, Au, Pt, and Cu. The hypotheses of Kundt and Dessau, Kaempf, Braun, and Ambronn to explain the Kundt double refraction are then collected and discussed, and it is shown that double refraction caused by the anisotropic arrangement of isotropic particles has certain characteristic properties, which are also found in Kundt's double refraction. G. E. A.

815. *Sensitising AgBr-gelatine.* **F. Wentzel.** (Zeitschr. wiss. Phot. 7. No. 5. pp. 113–137, April, 1909. Abstract of Dissertation, Berlin.)—AgCl is generally more easily colour-sensitised by dyes than AgBr is, but the suitable dyes are fewer in number: the effect is much the same as with AgBr, with some exceptions, both with regard to incorporating the dye in the emulsion and as to staining the plates. The maxima are not shifted by the ripening process. A. D.

816. *Absorption and Scatter of Light by Photographic Negatives.* **A. Callier.** (Photographic Journ. 49. pp. 200–210; Discussion, pp. 211–213, April, 1909. Translation.)—Tests made with a Martens polarisation photometer, under parallel and under diffused light. A silver deposit in a negative acts as a diffuser; relatively transparent portions have their light less scattered; therefore contrasts are increased (unless the negative, film outwards, is illuminated by opal glass in contact with it, without a condenser). Varnishing suppresses the scatter caused by the surface of the film, if the light be non-diffused. A. D.

817. *Absorption Spectra of Solutions of a Number of Salts in Water, in certain Non-aqueous Solvents, and in Mixtures of these Solvents with Water.* **H. C. Jones** and **J. A. Anderson.** (Amer. Chem. Journ. 41. pp. 163–208, March, and pp. 276–326, April, 1909.)—An abbreviated account of a complete investigation into the absorption spectra of many salts in solution, the full details of which are given elsewhere [Carnegie Institution Publication No. 110, 1909]. The solvents employed were ethyl and methyl alcohols, acetone, mixtures of these with water and water alone. The salts investigated were those of Co, Ni, Cu, Fe, Cr, Nd, Pr, Er, and the methods were either to vary the depth of the absorbing layer and the concentration so that the product of the two remained constant, or to vary the depth and concentration so that (1) the total number of ions, (2) the total number of undissociated molecules in the path of the light, remained constant. The results obtained are attributed to the formation of solvates or combination between the molecules or ions with the solvent. E. C. C. B.

818. *Relationship between the Constitution and the Absorption Spectra of Pyridine and Various Derivatives.* **J. E. Purvis.** (Chem. Soc., Journ. 95. pp. 294–301, March, 1909.)—The effect of HCl upon the absorption spectrum of α-picoline is very much the same as it is in the case of pyridine, the persistence of the band being greatly increased. It is noteworthy that the persistence of the band in the case of the free base is less than that of 2 : 6 lutidine. Some chlorine derivatives of α-picoline and α-picolinic acid have also been observed. The introduction of the chlorine atoms causes a great shift in the band

towards the red and also increases its persistence. It is pointed out that the general effect of substitution in the pyridine ring is to increase the persistence of the band and to shift it towards the red. Introduction into the side chains of substituted pyridines tends to decrease the persistence. The spatial relations of the substituent atoms have an important effect. [See also Abstracts Nos. 244, 777, and 1428 (1908).] E. C. C. B.

819. *Spectrophotometry with a Monochromatic Field.* **J. Thovert.** (Comptes Rendus, 148. pp. 625–626, March 8, 1909.)—If one examines the rays emerging from a spectroscope through a narrow slit, placed parallel to the collimator slit, the field appears illuminated with a uniform tint. If the rays from two sources be examined with this arrangement a spectrophotometric comparison can be carried out in a monochromatic field. E. C. C. B.

820. *Spectroscopic Investigation of Metallic Salts in Flames of Different Temperatures.* **H. Auerbach.** (Zeitschr. wiss. Phot. 7. pp. 30–39, Jan., and pp. 41–66, Feb., 1909.)—A complete study of the flame spectra of many metallic salts as obtained with a Bunsen burner and the air blast and oxygen blast flames. The spectra were photographed with a grating and also with a quartz-prism apparatus. E. C. C. B.

821. *The Complete Balmer Series in the Sodium Spectrum.* **R. W. Wood.** (Astrophys. Journ. 29. pp. 97–100, March, 1909. Phys. Zeitschr. 10. pp. 88–90, Feb. 1, 1909.)—In a previous paper [see Abstract No. 445 (1909)] the author described his discovery of a considerable extension of the principal series in the spectrum of Na which he had obtained by observing the absorption spectrum. With greater dispersion he has now succeeded in following the series as far as $n = 50$. It is very noteworthy that immediately beyond the head of the series there begins a considerable amount of general absorption which extends to the end of the ultra-violet. The author points out an interesting analogy with the continuous emission-spectrum given by hydrogen below the head of the series in the chromosphere. E. C. C. B.

822. *Radiation of various Spectral Lines of Neon, Helium, and Sodium in a Magnetic Field.* **J. E. Purvis.** (Cambridge Phil. Soc., Proc. 15. pp. 45–52, Feb. 23, 1909.)—The author has examined the magnetic resolution of some of the spectrum lines of Ne, and also the D lines of Na and the 5875 line of He which were given by a Ne vacuum tube. A concave grating of 21 ft. focus and an echelon grating of 18 plates were respectively used. In the case of Ne the highly complex resolutions of Lohmann were not confirmed [see Abstract No. 247 (1907)], owing, possibly, to the difficulty of differentiating between the components and the images arising from others. Lohmann used a 32-plate echelon grating and a field of 11,000 units, while the author used a field of either 24,000 or 26,100 units, so that the lower resolving power of his echelon should have been counteracted by the increase in intensity of the field. The measurements given in the paper show, except in certain cases, a good agreement with those previously published. E. C. C. B.

823. *Dissymmetrical Separations in the Zeeman-effect in Tungsten and Molybdenum.* **R. Jack.** (Roy. Soc. Edinburgh, Proc. 29. pp. 75–88, 1908–1909.)—An account of the normal and abnormal dissymmetrical resolutions

of the spectrum lines of W and Mo. By normal dissymmetry is meant those cases where the middle component of the triplet is nearer the component on the red side than that on the blue one, and in abnormal dissymmetry the middle component is displaced towards the blue. The apparatus used was a concave grating illuminated by a single quartz lens, so that a disturbing effect is introduced by the rotation of the polarised light. The experiments show that cases of dissymmetry arise which are due to the angle between the planes of vibration of the components and the lines of the grating. All cases, however, cannot be so accounted for, since abnormal dissymmetry is found where normal might be expected, and *vice versâ.* The possibility is suggested of the presence of couplings between electrons of different vibration-frequencies, in consequence of which the two triplets containing the coupled electrons become respectively an abnormal and a normal dissymmetrical triplet. E. C. C. B.

824. *The Emission and Absorption of Light incompletely Polarised in a Magnetic Field and the Zeeman-effect in Fluted Spectra.* **J. Becquerel.** (Comptes Rendus, 148. pp. 707–709, March 15, 1909.)—The author criticises Dufour's rule relating to the Zeeman-effect, which states the normal longitudinal Zeeman-effect gives doublets of which the circular polarisation is complete, but in the case of the abnormal effect the polarisation is incomplete. The bands of xenotime which show both normal and abnormal Zeeman-effects give doublets which are completely polarised in both cases. **A. Dufour.** (Ibid. pp. 775–776, March 22, 1909.)—Replying to Becquerel, Dufour states that his rule only applies to vapours and that it is general for these cases. E. C. C. B.

825. *Phosphorescence and Combustion of Sulphur.* **L. Bloch.** (Comptes Rendus, 148. pp. 782–783, March 22, 1909.)—The phosphorescence of sulphur occurring between 200° and 250° is accompanied by the production of much ozone, but no sulphurous odour. Above the temperature of phosphorescence the gas evolved has a camphoraceous odour, and at about 360° phosphorescence is replaced by the blue flame of burning sulphur. Many condensation nuclei are produced by the flame of combustion, but at no stage could any ionisation be detected with a very sensitive Curie electrometer, thus differing markedly from phosphorus [Abstract No. 165 (1909)]. The frequent ionisation of flames is attributed to chemical action, and not to the high temperature. W. H. St.

826. *N-rays and Variations in Resistance of Selenium.* **F. Bonola** and **G. Cavina.** (N. Cimento, 17. pp. 95–102, Jan.–Feb., 1909.)—The sensitiveness of the cell used is measured under white light and under the visible rays of the spectrum. Variations of resistance with CaS variously phosphorescing: application of the results to investigating N-rays through the variations they might cause in the phosphorescence of CaS. The results are entirely negative. A. D.

827. *Röntgen Rays: Ionisation and Pressure in Gases.* **J. A. Crowther.** (Cambridge Phil. Soc., Proc. 15. pp. 34–37, Feb. 23, 1909.)—Apart from secondary radiation, under Röntgen rays the ionisation per cm.^{3} of the gas varies as the pressure p, and $i = Ap$. Under secondary rays, $i = Bp^2$. Conjointly $i = Ap + Bp^2$. Experimentally the curves for gases are linear ($i = Ap$) except for ethyl bromide, in which the ionisation due to the secondary is

16 per cent. of that due to the primary. The effect of penetrating secondary rays may for other gases be neglected ; and there is, further, no appreciable ionisation produced by any soft secondary rays. A. D.

828. *Röntgen Rays: Ionisation produced in Different Gases.* **J. A. Crowther.** (Cambridge Phil. Soc., Proc. 15. pp. 38–39, Feb. 23, 1909.)—The relative ionisations produced by the hardest and softest practicable Röntgen rays run as follows : Air 1·0, 1·0 ; H_2 0·18, 0·01 ; CO_2 1·49, 1·57 ; methyl acetate 3·90, 4·95 ; ethyl chloride 17·3, 18·0 ; CCl_4 71, 67 ; C_2H_5Br 118, 72 ; CH_3I, 125, 145. Hydrogen is remarkable. [See also preceding and following Abstracts.] A. D.

829. *Passage of Röntgen Rays through Gases and Vapours.* **J. A. Crowther.** (Roy. Soc., Proc. Ser. A. 82. pp. 103–127, March 10, 1909.)—This forms a continuation of a previous research on the secondary Röntgen radiation from gases and vapours [see Abstract No. 61 (1908)]. The apparatus employed was, in the main, the same as that used in the former experiments, certain alterations and additions, however, being made to allow of the measurement of ionisation and absorption in the gas, in addition to the secondary radiation. The experiments are performed in various ways, according to the nature of the observations which it is desired to make. Simultaneous readings are made of the relative ionisation, coefficient of absorption, and secondary radiation so as to avoid all possibility of any difference in quality of the rays employed. The quality of the rays is regulated by the length of the spark-gap. The following gases were employed in these experiments : Air, hydrogen, CO_2, methyl acetate, ethyl chloride, CCl_4, methyl bromide, ethyl bromide, methyl iodide, mercury methyl and nickel carbonyl. The chief results obtained are : (1) The amount of ionisation produced by the direct action of the primary Röntgen rays on a gas is simply proportional to the pressure of the gas. No evidence is obtained of the emission of any appreciable amount of soft secondary radiation by the gas, the action being apparently due to the direct action of the primary rays. (2) The relative ionisation in the different gases compared with air as the standard, varies considerably with the hardness of the rays. Hydrogen and ethyl bromide show an increase as the hardness of the rays increases ; other gases remain constant or give a diminution. There is no indication of any approximation to a "density law" as the hardness of the rays is increased. (3) The relative ionisation in a gas depends on the number and nature of the different atoms present, and follows approximately an additive law. It does depend somewhat, however, on the state of combination, especially for soft rays. (4) The absorption varies with the pressure according to an exponential law. (5) The amount of secondary radiation emitted by different gases relative to air is, generally, approximately independent of the hardness of the primary rays. For very hard rays ethyl bromide shows a slight decrease. On the other hand, the values for methyl iodide increase fairly rapidly as the hardness of the rays is increased. (6) The absorption of the secondary rays emitted by a gas, in the gas itself, is not abnormal. (7) The total ionisation in different gases is not a constant, and the relative values obtained differ with the hardness of the rays. (8) The amount of energy required to produce an ion in different gases is different, and also varies with the hardness of the rays. No relationship is found between the relative ionisation and the secondary radiation, or between either, and any other known property of the gases and vapours, and no explanation is given of the relatively large amounts of secondary radiation emitted by ethyl bromide and its class compared with air, and of the large relative ionisation in methyl iodide, ethyl bromide, &c. It appears that, on the whole, less energy is required to produce an ion in the more ionisable gases, but the values obtained do not differ very largely, and are totally inadequate to explain the very large amounts of ionisation in these gases and vapours. Both the ionisation and the secondary Röntgen radiation follow, approximately, an additive law. It appears, therefore, that these properties are inherent to the atoms themselves, and that an explanation must be sought in their atomic structure. A. E. G.

830. *Ionisation of Röntgen Rays.* **C. G. Barkla.** (Nature, 80. p. 187, April 15, 1909.)—The relative ionisations produced in different gases by beams of Röntgen rays have been found to depend so markedly on the penetrating power of the rays used that no regularity in behaviour has been discovered [see preceding Abstract]. By experiments upon ethyl bromide it is now observed, that when the radiation passed through the vapour is made more penetrating than the radiation characteristic of bromine, the ionisation rapidly increases until the ratio of the ionisation in ethyl bromide to that in air, rapidly rises to several times its original value. The general conclusion arrived at is, that when a Röntgen radiation incident on a substance R is softer than the secondary radiation characteristic of R, it is absorbed according to a simple law, the absorption being approximately proportional to the absorption in any other substance in which a characteristic radiation is not excited ; it produces no appreciable quantity of this secondary radiation, and it produces what may be called a normal ionisation in R. When the incident radiation becomes more penetrating than the secondary radiation characteristic of R, it is absorbed by an amount greater than that given by the law stated ; it begins to excite the secondary radiation in R, and it produces an increased ionisation in R. The absorption and ionisation increase to several times their previous value, while the intensity of the secondary radiation becomes very great. The increase in ionisation is not, however, due to the secondary radiation. As the penetrating power of the incident rays is increased still farther, the absorption by R diminishes, and the secondary radiation excited in R diminishes, at the same rate as the ionisation produced by the incident radiation in a thin film of air. In compounds like ethyl bromide, methyl bromide, &c., the effects of the lighter elements are comparatively very small in respect to absorption, radiation, and ionisation. A. E. G.

831. *Range of action of the α-Rays.* **W. Duane.** (Ann. d. Physik, 28. 2. pp. 443–444, Feb. 4, 1909.)—The author replies to certain criticisms by Aschkinass on his former observations and notes [see Abstracts Nos. 1267, 1268, and 1958 (1908)], that : (1) Without the Bragg's screen the point on the charge curve at which the action of the α-rays sent out by radium ceases, is very much more sharply defined than the corresponding point on the ionisation curve. (2) This point on the ionisation curve can be much more accurately determined by using the Bragg's screen, which besides affords an always applicable method for the measurement of the length of path of the α-rays. (3) For the measurement of charge, however, the Bragg's screen cannot be applied since the charge is so small to commence with, and the screen stops so much of the rays that the portion traversing it with the actual apparatus and materials is scarcely to be estimated. (4) The use of the Bragg's screen can produce no change in the position of the point at which the ionisation due to radium ceases; the screen only makes it more easy to determine the position at which the oblique falling rays of the emanation and the induced activity cease. The author considers his experiments indicate that the ionisation may perhaps extend yet a *small* distance farther than the carrying along of the charge. J. J. S.

832. *β-Rays and Photo-sensitive Solutions.* **O. Flaschner.** (Chem. Soc., Journ. 95. pp. 327–331, March, 1909.)—There is a similarity between the chemical effect of light and that of β-rays. The potential of an AgBr/KBr electrode is changed under the influence of β-rays in the same direction as it would be by the action of light; and the higher the initial potential the more sensitive is the electrode to β-rays, just as in the case of light. Similar results are obtained with β-rays and an Eder actinometer (precipitation of calomel from a solution of $HgCl_2$ and ammonium oxalate, with liberation of CO_2). A. D.

833. *Velocity of Kathode Rays ejected by Substances exposed to the γ-Rays of Radium.* **R. D. Kleeman.** (Roy. Soc., Proc. Ser. A. 82. pp. 128–145, March 10, 1909.)—The kathode radiation from a substance exposed to γ-rays of Ra consists partly of rays of a very penetrating character. Two methods are used in these experiments. One of the methods consists in measuring the scattering of the kathode particles produced by different thicknesses of metal placed in the path of the rays. In the other method the kathode rays are deflected into an ionisation chamber by means of a strong electromagnet, and the ionisation in the chamber is measured for magnetic fields of different strengths. The γ-rays are produced by 30 mgm. of $RaBr_2$ enclosed in a glass tube and placed in the cavity of a lead cylinder, the cavity being closed by sheet-lead 3 mm. thick, so as to cut off the β-rays. A description with diagrams of the apparatus used is given. Part of the kathode radiation from a plate exposed to the γ-rays of Ra consists of very soft rays, which are absorbed in 1 or 2 cm. of air. The softness of the radiation is practically independent of the thickness of the radiator and previous sifting of the γ-rays through a thick screen. The radiation appears to be considerably softer on the side of the radiating plate where the γ-rays emerge than on the side where they enter. Measurements of the softness of the radiation for radiators of different materials on the side where the γ-rays entered show that it is practically independent of the nature of the material of the radiator. The soft radiation produced by the β- and γ-rays of radium together is of a more penetrating character than that produced by the γ-rays alone. The penetrating kathode rays produced directly by the γ-rays have been shown to possess different velocities. It is now found that the penetrating power of the kathode radiation from a plate decreases with the absorbability of the γ-radiation which produces it. The velocity of these secondary rays as a whole is, as a first approximation, equal to that of the β-rays of Ra. Assuming the truth of the ether-pulse theory, and using Ladenburg's statement that the product of the velocity of a beam of secondary kathode rays into the wave-length of the ultra-violet light producing it is constant, it is calculated that the thickness of a γ-ray pulse is just about equal to the diam. of a molecule. A. E. G.

834. *Coefficient of Diffusion of Actinium Emanation.* **G. Bruhat.** (Comptes Rendus, 148. pp. 628–631, March 8, 1909.)—The molecular weight of radio-active emanations may be found by determining their coefficients of diffusion and comparing these with those found for gases of known molecular weight. Experiment shows that there is a coefficient of diffusion independent of the concentration, and the author has investigated how it varies when the nature and the pressure of the gas in the midst of which the diffusion takes place is made to vary. The coefficients were measured by the method used by Debierne. A layer of a compound of Ac being placed at the bottom of a box, a permanent condition of diffusion is allowed to establish itself in the box, and then the distribution of the emanation between two parallel plates placed in the box is determined by measuring the induced activity at different points of one of these plates. If the planes are sufficiently long the distribution varies according to an exponential law which is easily deduced from the value of the coefficient of diffusion. The coefficient of diffusion of the emanation of actinium into air has been measured between atmospheric pressure and 0·9 cm. of mercury, and it was sought to observe whether it varied inversely as the pressure, as for gases. Correction was made for temperature changes by supposing that the coefficient of diffusion is proportional to the square of the absolute temperature: the product pD/T^2 should then be constant. A table is given of the various values found at different pressures, and the mean value for the quantity pD/T_2 is 10·1. The coefficient of diffusion changes from 0·112 at 76 cm. of mercury to 9·1 at 0·9 cm. The coefficient and the pressures are correct within an approximation of 1/100, and the departures from the mean value of the quantity sought are less than the errors of experiment. The corrections for temperature appear to be legitimate. The coefficients of diffusion in hydrogen and CO_2 were also measured, and are found to be respectively 0·077 for CO_2 and 0·412 for hydrogen at 76 cm. of mercury. To calculate the molecular weight of the emanation it is necessary to take the ratio of its coefficient of diffusion to that of another gas under the same conditions. The diffusion coefficient being inversely proportional to the pressure, this ratio will be independent of the conditions of pressure, and it will be the same whether the diffusion takes place in CO_2 or hydrogen. The following are the ratios in different cases—

Ether	$D_{CO_2}/D_{Air} =$ 0·71	$D_H/D_{Air} =$ 3·8
Alcohol........................	0·67	3·7
Water	0·67	3·5
CO_2	—	3·8
Emanation of Actinium	0·68	3·7

The same molecular weight of about 70 is thus always indicated for the emanation whatever the conditions of the diffusion; hence the hypotheses made in calculating this molecular weight may be regarded as legitimate, and the value obtained may be considered as fixing at least the order of magnitude. The experiments described performed in 1908 agree with those published by S. Russ [see next Abstract]. J. J. S.

835. *Diffusion of Actinium and Thorium Emanations.* **S. Russ.** (Phil. Mag. 17. pp. 412–422, March, 1909. Paper read before the Physical Soc., Nov. 27, 1908.)—The diffusion coefficients of actinium emanation in air, hydrogen, CO_2, and SO_2 were determined, with a view to attaining a knowledge of the molecular weight of the emanation. In order to measure the coefficient of diffusion of actinium emanation (presumably monatomic) into a monatomic gas, argon was prepared, and the coefficient obtained by two methods. The theory of the method adopted for obtaining the value required has been given by Rutherford (*Radioactivity*, p. 275). The theory also applies when the emanation is allowed to diffuse up into the space between two parallel plates, as has been shown by Debierne. [This latter method has been employed in simultaneous experiments carried out independently by G. Bruhat (see preceding Abstract)]. The value of the diffusion coefficient of actinium emanation (K) was determined by two different methods, and the mean values found when the emanation diffused into different gases are as follows :—

Diffusion Coefficient K.	Air.	Hydrogen.	CO_2.	SO_2.
	Mean of Three.	Mean of Two.	Mean of Two.	Mean of Two.
Experimental.........	0·096	0·330	0·078	0·062
Calculated	—	0·363	0·078	0·064

The differences between the experimental and calculated values get larger on going from a heavy gas to a light one, but even for hydrogen there is agreement to within about 10 per cent. The results of the two methods of observation in the case of diffusion of AcEm in air and argon by the two methods employed are :—

Diffusion Coefficient K.	Parallel Plates Method.		Segmented Rod Method.	
	Mean of Three.		Mean of Two.	
	Air.	Argon.	Air.	Argon.
Experimental.........	0·118	0·106	0·122	0·109
Calculated	—	0·100	—	0·104

The coefficients obtained by the two different methods agree together, and also with the numbers calculated from Graham's Law, making use of the numerical values obtained for air. The variation of the coefficient of diffusion of AcEm with pressure was also determined, with the following results :—

	1·4 cm. Hg.	4·1 cm.	8·0 cm.	15·5 cm.	37·1 cm.	55·8 cm.	76·4 cm.
Diff. coeff. K...	7·81	2·37	1·16	0·582	0·248	0·167	0·125
Pressure × K...	10·9	9·7	9·8	9·0	9·2	9·3	9·5

Mean value of P × K = 9·84.

Thorium emanation was also examined, and the following values were found :—

	Air.				Argon.
	8·25 cm.	17·5 cm.	37·52 cm.	76·12 cm.	76 cm.
K	0·966	0·436	0·211	0·108	K experimental 0·084
P × K	7·97	7·63	7·94	7·88	K calculated 0·087

Taking the mean value of P × K for AcEm in air as 9·34 and for ThEm as 7·85, and dividing each by 76 to reduce to atmospheric pressure, then: (diffusion coeff. of AcEm in air)/(diffusion coeff. of ThEm in air) = 0·123/0·103 = 1·19, which gives the ratio: (Molec. wt. of ThEm)/(Molec. wt. of AcEm) $= (1{\cdot}19)^2 = 1{\cdot}42$. Previously Rutherford obtained for ThEm a diffusion coefficient 0·09, and Makower found 0·109. Debierne has obtained for AcEm the value 0·112. [The value found by Bruhat (*loc. cit.*) agrees with that of Debierne at 76 cm. pressure, viz., 0·112.] Taking the mean of the two values given for ThEm as 0·99 the ratio of the molec. wts. in the case of the two emanations is $(0{\cdot}112/0{\cdot}99)^2 = 1{\cdot}28$. The conclusion arrived at is that the ratio of the molecular weights of actinium and thorium emanations is 1·42, that of Th being the greater. [The values given for AcEm agree fairly well with those determined independently and simultaneously by Bruhat, the latter observer correcting for temperature, and taking the coeff. of diffusion as proportional to the square of the absolute temperature (see preceding Abstract).] J. J. S.

836. *Radio-activity of Potassium Salts.* **E. Henriot.** (Comptes Rendus, 148. pp. 910–912, April 5, 1909.)—The salts of potassium have been shown to possess a feeble radio-activity. The question arises, Is this activity due to the presence of traces of other known radio-active bodies? A noticeable feature of the radio-activity is that it does not diminish with time. Previous experimenters have declared that the radiation is very heterogeneous, the penetrating power of the rays being of the order of the β-rays of uranium. The author, however, concludes from his measurements that the radiation is homogeneous. With 1 kg. of a potassium salt spread over a surface of 1,800 cm.^{2} he investigates the absorption produced by thin layers of tin by measuring the ionisation produced by the transmitted rays, using a Wilson electroscope. Plotting the logarithm of the ionisation current for the sulphate and chloride against the thickness of tin, the points lie on a straight line. There is, however, some slight evidence of the presence of slightly penetrating rays of the α kind, but as the quantity of this radiation varies even with the same salt, it is probably due to impurity. The author therefore concludes that the radio-activity is not due to any known radio-active element, but that they are β-rays due to the potassium itself or to some unknown body which is always associated with it. W. C. S. P.

837. *Presence of Thorium in Rocks.* **G. A. Blanc.** (Accad. Lincei, Atti, 18. pp. 241–246, March 7, 1909.)—The proportion of thorium in various samples of rock has been determined by separating it from silica and

radium, in the form of hydroxide, and measuring the rate of discharge of an Al-leaf electroscope (1) when some of the hydroxide alone was introduced, (2) when a mixture containing known amounts of hydroxide and of pure thorium hydroxide was introduced, and (3) *in vacuo*. Two specimens of sienite from Biella contained $8{\cdot}28 \times 10^{-4}$ and $6{\cdot}30 \times 10^{-5}$ gm. per gm. respectively, granite from Baveno (Lake Maggiore) $3{\cdot}14 \times 10^{-5}$, and granite from the Vosges $2{\cdot}07 \times 10^{-5}$, quantities similar to that found in the soil at Rome [Abstract No. 681 (1908)]. A sample of protogine from Savoy showed no appreciable quantity of thorium. The author considers that thorium is as important a factor as radium, if not more so, in the radio-activity of the earth's crust. W. H. Si.

838. *Problems in Radio-activity.* **A. S. Eve.** (Terrestrial Magnetism, 14. pp. 25–36, March, 1909.)—From the author's results for the amount of radio-active deposit on a charged wire over the Atlantic, it appears that the amount in mid-Atlantic does not differ greatly from that in Canada or in England; but it must be remembered that the amount of active deposit determined at any given locality is liable to considerable variations. Such changes are apparently due partly to meteorological conditions, partly to fluctuations in the amount of emanation in the air. The amount of RaEm found in mid-ocean is too great for it to be entirely borne by wind from the land, so that emanation must enter the air from the ocean somewhat as from the land. This is an unexpected result, for the radium per c.cm. of rock is about $8{\cdot}8 \times 10^{-12}$ gm. (Strutt), and per c.cm. of sea water $1{\cdot}6 \times 10^{-14}$ gm (Joly); but emanation escapes readily when radium is in solution, especially perhaps from a surface agitated as that of the ocean. Other observers have found less active deposit near the sea-coast than inland. For example, Elster and Geitel obtained a value 6 for the Island of Juist, near Denmark, 18·6 at Wolfenbüttel, 84 at Freiburg, and 187 among the Bavarian Alps. Simpson obtained 58 on the coast at Hammerfest, and 126 inland at Karasjok; and at the former station a sea-breeze gave much less than a land-breeze. As regards the positive and negative ions in the atmosphere, most observers have found an excess of positive ions. But reverse effects are sometimes found. Such cases are reported by Dike in the "doldrums," and by Smirnov during balloon ascents. Recent work by Bates and the author [see Abstract No. 672 (1909)] indicates that the quantities of positive and negative ions do not differ to the extent indicated by Ebert's apparatus. A discussion is next given of ionisation theory and of the ratio of the penetrating radiation values for land, sea, and air. Using experimental values obtained by various workers it appears that the number of ions present at any instant over the land should be nearly twice as great as over the ocean. But Boltzmann, Dike, and the author have found no such disparity. Hence, while the radio-active matter known to be present in the earth and air is sufficient to account for the observed ionisation in the atmosphere near the earth's surface, the amount present in sea and air appears to be inadequate to account for the ionisation of the air over the surface of the ocean. Dealing with the thorium products in the atmosphere the author concludes that as a first approximation: (i.) Th and Ur are present in the surface rocks and soils in nearly equal amounts; (ii.) the heating effects due to them and their subsequent products (including the Ra family with Ur) are of the same order. Indeed Blanc, from his observations near Rome, finds that thorium is the more important as a heat producer in the earth's outer crust. But Strutt found the radium in the surface rocks more than sufficient to account for the existing temperature gradients, and the presence of the thorium intensifies the difficulty. Strutt has suggested that the character of the constitution of the earth changes a few miles down, and his suggestion has been supported by Milne. Again, if the earth had consisted of a solid sphere of uranium 94 thousand million years ago, it would account for the radium present to-day. This is scarcely possible, as the period named is perhaps 500 times geological time. We are driven, then, to the conclusion that uranium must have been integrated from elements of less atomic weight. Briefly, some of the problems awaiting solution are : (1) Is the number of positive ions in the atmosphere near the earth's surface really greater than the number of negative ions ? (2) If so, how is the excess caused ? (3) What are the relative quantities over land and ocean of the products of radium and thorium ? (4) While the radio-active theory of the ionisation of the atmosphere over land is on the whole satisfactory, the radio-active matter in the air and ocean appears to be too small to account for the ionisation and conductivity of the air over the ocean. (5) How has been obtained or how maintained the supply of uranium, from which the radium existing in the earth has been derived ? A. W.

839. *Emanation of Sea Water from Atlantic.* **W. Knoche.** (Phys. Zeitschr. 10. pp. 157–158, March 1, 1909.)—Describes measurements of the emanation from samples of sea water taken from different places in a voyage across the Atlantic. The mean value obtained from 12 determinations was 0·00012 in absolute units. A. W.

REFERENCES.

840. *Two Monochromatic Spectral Apparatus for Homogeneous Light.* **C. Leiss.** (Zeitschr. Instrumentenk. 29. pp. 68–71, March, 1909. Communication from optical works of R. Fuess.)—Illustrated.

841. *Arrangement for taking Microscopical Observations at Low Temperatures.* **H. E. Boeke.** (Zeitschr. Instrumentenk. 29. pp. 72–74, March, 1909.)—Illustrated description of a simple device made by Fuess for which the original pages should be consulted.

842. *Effect of Light of Different Colours on Visual Acuity.* **J. S. Dow, L. Weber.** (Illum. Engin., London, 2. pp. 233–240, April, and pp. 345–347, May, 1909.)

843. *A Question in Absorption Spectroscopy.* **R. A. Houstoun** and **A. S. Russell.** (Roy. Soc. Edinburgh, Proc. 29. pp. 68–74, 1908–1909.)—The question has been investigated by the authors as to whether any change in absorption is produced on mixing two absorbing solutions which do not act chemically upon one another. Most careful experiments were carried out, but with only negative results. E. C. C. B.

844. *Normal Lines of the Arc-spectrum of Iron in a Definite Rowland System.* **J. Hartmann.** (Phys. Zeitschr. 10. pp. 121–124, Feb. 15, 1909. Astrophysikal. Observatorium, Potsdam, Dec., 1908.)—The author gives a table of wave-lengths to be adopted as a standard, based upon interference standards and Rowland's tables. E. C. C. B.

845. *Arc Spectrum of Iron.* **E. J. Evans.** (Astrophys. Journ. 29. pp. 157–159, March, 1909.)—Investigation of lines of arc spectrum of iron between λλ6855–7412 for reference as standard lines. C. P. B.

846. *The Red Portion of the Arc Spectra of Nickel, Cobalt, and Chromium.* **L. Stüting.** (Zeitschr. Wiss. Phot. 7. pp. 73–88, March, 1909.)—A measurement of the red region of the spectra of Ni, Co, and Cr, using a large concave grating and the panchromatic plates of Wratten and Wainwright. The measurements are all based upon Fabry and Buisson's standards and extend from λ5900 to λ7100. [See Abstract No. 1345 (1907).] E. C. C. B.

847. *Arc Spectrum of Titanium.* **E. J. Evans.** (Astrophys. Journ. 29. pp. 160–163, March, 1909.)—Table of wave-lengths of titanium arc spectrum between λλ5866·675 and 7364·50. C. P. B.

848. *Normal and Abnormal Changes of certain Bands in the Emission Spectra of the Molecules of Different Substances in the Gaseous State under the Influence of a Magnetic Field.* **A. Dufour.** (Soc. Franç. Phys., Bull. 3. pp. 225–253, 1908. Journ. de Physique, 8. pp. 237–264, April, 1909. Phys. Zeitschr. 10. pp. 124–138, Feb. 15, 1909.)—A complete account of the author's and other experimenters' work upon this subject. E. C. C. B.

849. *Change of Wave-length of the Middle Line of Triplets.* **P. Zeeman.** (Phys. Zeitschr. 10. pp. 217–221, April 1, 1909.)—A continuation of the author's investigations upon the asymmetrical magnetic resolution of certain spectrum lines, especially Hgλ = 5791. E. C. C. B.

850. *Distribution of Rays near Radio-active Bodies.* **H. Greinacher.** (Phys. Zeitschr. 10. pp. 145–152, March 1, 1909. Physikal. Inst. d. Univ., Zürich, Feb., 1909.)—A further discussion of the work previously dealt with [see Abstract No. 1266 (1908)]. Fresh experimental evidence is given to support the author's views, and the subject is also treated mathematically, use being made of Lambert's law. A. W.

851. *Radio-activity of the Waters of Graz and its Neighbourhood.* **A. Wellik.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 1191–1226, Oct.–Nov., 1908.)—Includes tables giving the activities of the different sources examined.

852. *Radio-activity of the Sulphurous Thermal Waters of Bagnères-de-Luchon.* **C. Moureu** and **A. Lepape.** (Comptes Rendus, 148. pp. 834–837, March 29, 1909.)

853. *Recent Researches in Radio-activity.* **E. Rutherford.** (Chem. News, 99. pp. 171–174, April 8, and pp. 181–183, April 16, 1909. Discourse delivered at the Royal Institution, Jan. 31, 1908.) [See Abstract No. 790 (1908).]

HEAT.

854. *Specific Heats of Solutions.* I. **H. Schlesinger.** (Phys. Zeitschr. 10. pp. 210–215, March 15, 1909. From the physikal.-chem. Inst. d. Univ., Berlin.)—The author describes a method for determining the specific heat of a liquid at different temperatures. The principle of the method is to develop a known amount of heat in the body of the liquid by means of an electric current passing through a Pt wire, and to note the increase of volume produced. From the known coefficient of expansion of the liquid the specific heat can then be calculated. The specific heat of sulphuric acid of various concentrations, and of pentane, is communicated. A. F.

855. *Ignition Temperatures of Gases.* **H. B. Dixon and H. F. Coward.** (Chem. Soc., Journ. 95. pp. 514–543, March, 1909.)—The temperature to which two gases must be heated in order that they inflame immediately they are brought into contact has been determined by passing an inflammable gas up a tube terminating in a nozzle and fixed in the middle of a second electrically heated tube conveying a current of air or oxygen. The temperature of the gas was measured 2 mm. below the nozzle. The ignition temperature of hydrogen, thus measured, is constant within 10° and does not vary with: (1) the rates of flow of the gases, within wide limits; (2) the size, material, and surface condition of the jet and of the walls of the furnace; (3) the rate of heating of the furnace; (4) the position of the thermo-junction, either inside or just outside the nozzle. The ignition-temperature was at first lowered about 20° by increasing the diam. of the outer tube, but a limit was then reached when doubling the diam. produced no further lowering. The ignition temperature was raised 5° by working under 0·5 atmos. pressure, but lowered by 30° under 2 atmos. pressure. The ignition temperatures of the paraffins and ammonia are not so clearly defined as those of hydrogen, CO, and other gases, as they vary with the rates of flow of the gases, as well as with the size of the furnace tube. The following are the values of the ignition temperature obtained:—

	In Oxygen.		In Air.	
	Range.	Mean.	Range.	Mean.
Hydrogen	580–590°	585°	580–590°	585°
Carbon monoxide (moist)	637–658	650	644–658	651
Cyanogen	803–818	811	850–862	856
Ethylene	500–519	510	542–547	543
Acetylene	416–440	428	406–440	429
Hydrogen sulphide	220–235	227	346–379	364
Methane	556–700	—	650–750	—
Ethane	520–630	—	520–630	—
Propane	490–570	—	—	—
Ammonia	700–860	—	—	—

T. H. P.

856. *Compressibility of Gases between* 0 *and* 8 *Atmospheres Pressure and at all Temperatures.* **A. Leduc.** (Comptes Rendus, 148. pp. 407–410, Feb. 15, and pp. 548–550, March 1, 1909.)—The author returns to the question of the calculation of molecular volumes [see Abstracts Nos. 64, 800, 1187 (1898); 1491 (1899)], taking account of the more recent determinations of critical constants. In spite of Rayleigh's work, according to which gases obey Boyle's law exactly at very low pressures, the author is of opinion that the deviation from that law is represented by a modified form of one of Regnault's formulæ, namely, $E = p_1 v_1/pv - 1 = a(p - p_1) + b(p - p_1)^2$, pressures being in cm. of mercury and the initial pressure p_1 being 76 cm. The coefficient of deviation, $-\partial(pv)/pv\partial p$ is equal to or less than 10^{-6} for the old permanent gases and equal to or less than 10^{-4} for gases resembling CO_2 at 0°. The deviation given above may be put into the form $E' = 1 - pv/p_0 v_0 = mp + np^2$, and the coefficients m and n are calculated for 18 gases, the compressibilities of which were previously studied (*loc cit.*) at temperatures approximating to 16°. Writing the equation of state in the form $Mpv = RT\phi$, the molecular volume ϕ of the gas taken in relation to the perfect gas does not differ sensibly from the ratio $pv/p_0 v_0$, which is the molecular volume in relation to the perfect gas at the limit of rarefaction. Representing the critical pressure by π, $\phi = 1 - mp - np^2 = 1 - m\pi(p/\pi) - n\pi^2(p/\pi)^2$. For one and the same value of the reduced pressure p/π, ϕ should depend only on the reduced temperature, so that $m\pi$ and $n\pi^2$ are functions only of the latter or of its reciprocal, χ. π being measured in atmos. for 15 gases, $m\pi$ is represented sufficiently exactly by one of the formulæ : $z = m\pi \times 10^4 = \chi(-19{\cdot}8 + 54\chi - 27\chi^2 + 38\chi^3)$ or $z = 18{\cdot}85\chi(2\chi^3 - \sqrt{2}\chi^2 + 2\sqrt{2}\chi - 1)$.

T. H. P.

857. *Gas Molecules per Unit Volume.* **P. Ghose.** (Nature, 80. p. 39, March 11, 1909.)—An endeavour to calculate the value of N for helium without assuming Avogadro's hypothesis or the known value of N for any other gas. Various methods are adopted leading to the five values: 0·017, 1·4, 2·8, 3·6, and 4, each to be multiplied by 10^{19}. It is believed safer to adopt the middle of these values, $2{\cdot}8 \times 10^{19}$, which is obtained from van der Waals' equation, and compares well with $N = 2{\cdot}72 \times 10^{19}$ yielded by the counting experiment of Rutherford and Geiger [Abstracts Nos. 1628 and 1960 (1908)].

E. H. B.

858. *A New Determination of the Vapour Pressure of Water between* 50° *and* 200°. **L. Holborn** and **F. Henning.** (Zeitschr. Vereines Deutsch. Ing. 53. pp. 302–304, Feb. 20, 1909. Communication from the Physikal.-Techn. Reichsanstalt.)—For the determinations between 100° and 200° C. the water was contained in a strong copper cylinder and was heated electrically, the temperature of the vapour being obtained by means of a Pt-resistance thermometer. In communication with the cylinder was a vessel of 80 litres capacity, the air in which underwent pressures up to 12 m. of mercury [see also Abstract No. 1646 (1908)]. At this max. pressure the manometer could be read to 0·2 mm. For temperatures below 100° C. a simpler piece of apparatus was used with a more delicate manometer. The resistance thermometer was standardised by comparison with a nitrogen thermometer. Combining their results with those obtained by Thiesen and Scheel for the temperature range 0–50°, the authors give the following table of vapour pressures for every degree between 0° and 200°:—

Vapour Pressure of Water (mm. of Mercury).

	0.	1.	2.	3.	4.	5.	6.	7.	8.	9.
0°	4·579	4·924	5·290	5·681	6·097	6·541	7·011	7·511	8·042	8·606
10	9·205	9·840	10·513	11·226	11·980	12·779	13·624	14·517	15·460	16·456
20	17·51	18·62	19·79	21·02	22·32	23·69	25·13	26·65	28·25	29·94
30	31·71	33·57	35·53	37·59	39·75	42·02	44·40	46·90	49·51	52·28
40	55·18	58·14	61·30	64·59	68·05	71·66	75·43	79·38	83·50	87·80
50	92·30	96·99	101·88	106·99	112·30	117·85	123·61	129·63	135·89	142·41
60	149·19	156·24	163·58	171·20	179·13	187·36	195·92	204·80	214·02	223·58
70	233·53	243·8	254·5	265·6	277·1	289·0	301·3	310·0	327·2	340·9
80	355·1	369·7	384·9	400·5	416·7	433·5	450·8	468·6	487·1	506·1
90	525·8	546·1	567·1	588·7	611·0	634·0	657·7	682·1	707·3	733·3
110	760·0	787·5	815·9	845·1	875·1	906·1	937·9	970·6	1,004·3	1,038·8
100	1,074·5	1,111·1	1,148·7	1,187·4	1,227·1	1,267·9	1,309·8	1,352·8	1,397·0	1,442·4
120	1,488·9	1,536·6	1,585·7	1,636·0	1,687·5	1,740·5	1,794·7	1,850·3	1,907·3	1,965·8
130	2,025·6	2,086·9	2,149·8	2,214·0	2,280·0	2,347·5	2,416·5	2,487·3	2,559·7	2,633·8
140	2,709·5	2,787·1	2,866·4	2,947·7	3,030·5	3,115·3	3,202·1	3,290·8	3·381·3	3,474·0
150	3,568·7	3,665·3	3,764·1	3,864·9	3,968	4,073	4,181	4,290	4,402	4,517
160	4,633	4,752	4,874	4,998	5,124	5,253	5,384	5,518	5,655	5,594
170	5,937	6,081	6,229	6,379	6,533	6,689	6,848	7,010	7,175	7,343
180	7,514	7,688	7,866	8,046	8,230	8,417	8,608	8,802	8,999	9,200
190	9,404	9,612	9,823	10,038	10,256	10,479	10,705	10,934	11,168	11,406
200	11,647	11,893	12,142	12,395	12,653	12,915	—	—	—	—

W. C. S. P.

859. *Temperature Radiation and the Partition of Energy.* **J. H. Jeans.** (Phil. Mag. 17. pp. 229–254, Feb., 1909.)—Attempts a critical examination of some of the difficulties which surround the application of the law of equipartition of energy to the energy of wave-motion in the ether or other continuous media. These difficulties manifest themselves most clearly in connection with the problem of determining the law of partition of radiant energy inside a uniform-temperature enclosure. The author considers the case of several bodies placed inside an enclosure whose walls reflect energy perfectly. When all the bodies have assumed the same temperature, the energy per unit volume of radiation is a function $F(\lambda, T)$ of the wave-length and the absolute temperature. Assuming that the law of equipartition of energy applies, this function can at once be shown to equal $8\pi RT\lambda^{-4}$. If the walls are no longer perfect reflectors, but are kept at a uniform temperature T, and a steady stream of energy $f(\lambda, T)$ issues from a small aperture in the enclosure, this energy is, according to Planck—

$$f(\lambda, T) = (8\pi c/\lambda^5)\left[1/(e^{c/kT\lambda} - 1)\right],$$

which is confirmed by experiment. The author maintains that the application of the equipartition theorem is legitimate, but that its utility is impaired by the enormous time required for attaining a steady state. The theorem simply represents the tendency of energy to become degraded into irregular disturbances of the medium. The formulæ for F and f become identical at long wave-lengths. The continuous spectrum emitted by a solid proceeds from the motion of free electrons. The motion of these electrons can be analysed into the motion of wave-trains, each possessing energy appropriate to the temperature. There is an extremely rapid transfer of energy between these waves of electrons and the ether in which they are embedded. The ether in the interior of matter will immediately take up its equilibrium part of energy $8\pi RT\lambda^{-4}d\lambda$. But the analysis of the electron motion into regular trains of waves holds only for wave-lengths great compared with the distances apart of the nearest electrons. E. E. F.

860. *Radiation Constants of Metals.* **W. W. Coblentz.** (Bureau of Standards, Bull. 5. pp. 339–379, Feb., 1909.)—The energy radiated by a black body and also by platinum is given by $E = c_1\lambda^{a}\epsilon^{-c_2/\lambda T}$...(1) and the shifting of the maximum of the energy curve by $\lambda_{max.} T =$ const., the symbols having their usual meanings. The object of the investigation was to obtain some estimate of the emissivity of incandescent metal filaments, *e.g.*, tantalum, tungsten, and osmium, the assumption being made that their spectral energy distribution follows (1). The results obtained are, in the author's opinion, not very satisfactory. A probable reason is because the filaments are made of particles of metal mixed with a binder and squirted into a thin thread, after which the binder is removed, leaving the metallic particles welded together in various degrees of homogeneity and purity. Until, therefore, homogeneous strips of these metals are obtainable a further investigation with these filaments is unnecessary, as high accuracy is not possible. The results obtained show that the so-called radiation constant a of all the metals examined is higher than that of Pt at the same temperature. For osmium the value of a was 7, which was the highest value obtained. Although the individual computations of the "constant a" vary from 3 to 5 per cent., the results obtained are concordant in being uniformly high or uniformly low for a given energy consumption. Contrary to the results obtained in preceding investigations, it was found that a decreased uniformly with rise of temperature. Theoretically this could have been anticipated, but the present results are not sufficiently definite to determine whether the change takes place abruptly or gradually. It is therefore an open question whether there is a radiation constant a for metals. This question is of vital importance in connection with optical pyrometers. Further spectro-bolometric work will have to be undertaken to settle this question. A. R.

861. *On the Approximation of Black Bodies which are employed as Receivers.* **C. Féry.** (Comptes Rendus, 148. pp. 777–780, March 22, 1909.)—The author remarks that in the determination of the radiation constant by the application of Stefan's Fourth-power Law insufficient attention is paid to the nature of the receiver. He has therefore carried out experiments to determine if the black surfaces which are usually used to receive radiation possess selective absorption. Radiation from an electric resistance furnace is allowed to fall on a flat plate and the absorption is compared with that which takes place when the same radiation falls on a similar surface consisting of a conical cavity. In the latter case there will be, for regular reflection, a number of reflections $N = 180°/a$, where a is the angle of the apex of the cone. The receivers in both cases constitute one junction of a thermo-element. If now Δ be the deviation of the galvanometer obtained with the cone and δ the deviation when the flat plate is used, we may define the reflecting power of the surface for radiation of given wave-length as $R = (\Delta - \delta)/\delta$. Curves are given showing the relation between the reflecting power and the wave-length up to 8 μ. In the case of a specially prepared smoke-black surface the reflecting power is small but increases uniformly with the wave-length; but for surfaces of platinum black the reflection is very marked and shows a maximum power at about 6 μ. The results have been confirmed by means of the author's optical pyrometers. He allowed the radiation to fall on one thermo-couple which had been smoked as before, and on another which had been platinised. The absorption curves so obtained were complementary to the previous curves of reflection, there being a minimum of absorption at about 6 μ in the case of the platinised couple. W. C. S. P.

862. *Contribution to the Study of Radiation.* **G. Millochau.** (Comptes Rendus, 148. pp. 780–782, March 22, 1909.)—By comparing the radiation from the sun with that obtained from an electric furnace we may, by application of Stefan's Law, obtain a value of the effective temperature of the sun. This, combined with a knowledge of the absolute solar radiation as obtained by means of an actinometer, leads to an indirect determination of the radiation constant. The results so obtained show considerable disagreement. Measurements made on solar radiation with the pyrheliometer of Féry and his actinometer show that the laws of the instruments are the same; apparently the deflections are proportional to the intensity of radiation of the source. But experimenting in the laboratory it is found that the power in watts which has to be given to the instruments is not proportional to the deflection produced thereby. The author points out that the black receiver of the actinometer really acts as a screen, and in order to measure the true radiation the receiver should have the properties of a full radiator [see preceding Abstract]. An experiment is quoted in which the Féry actinometer is placed a certain distance from a furnace at a known temperature. The results correspond exactly with some recent experiments by Scheiner, who used an Ångström actinometer. W. C. S. P.

863. *Proof of the Radiation Law in the Case of the Bunsen Flame.* **H. Schmidt.** (Deutsch. Phys. Gesell., Verh. 11. 3. pp. 87–102, Feb. 15, 1909. Physikal. Inst. d. Univ., Berlin.)—The essential part of this investigation lies in the measurement of the temperature of the flame. A thin strip of metal was heated electrically and its temperature measured by means of the optical pyrometer. A curve was then plotted of temperature against electrical energy. The metal strip was then put into a Bunsen flame, and again the relation between temperature and electrical energy determined. The point at which this second curve crossed the first marks the true temperature of the flame. These measurements coupled with observations of the absorption by the flame (carried out with a radio-micrometer), establish the validity, within the limits of experimental error, of the law of temperature radiation as applied to the Bunsen flame. E. C. C. B.

864. *Emissivity of Metals at different Temperatures.* **E. Hagen** and **H. Rubens.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 16. pp. 478–492, 1909. Communication from the Physikal.-Techn. Reichsanstalt.)—In continuation of previous work [see Abstracts Nos. 62, 64 (1904)] the variation of emissivity with temperature is measured up to 500° and compared with the values calculated from $E = 36{\cdot}5\sqrt{(\sigma/\lambda)}$, where E is the emissivity, σ the specific resistance of the material of the emitting surface, and λ the wave-length of the rays emitted. The value of σ at various temperatures was measured by means of wires made of the same material as that used for the emission experiments. The results show that the agreement between theory and experiment is close, for, whilst the emissivity of pure metals changes by about 60 per cent. for the rise of temperature between 100° and 500°, there was no decided change in the ratio of the calculated and observed emissivities. With nickel there is a point of inflection in the resistance curve at the temperature at which that metal becomes non-magnetic, and there is a corresponding point in the emission curve. For the region of the spectrum investigated, viz., between $8{\cdot}85\,\mu$ and $26\,\mu$, the "optical" temperature-coefficients of metals coincide almost completely with the "electrical" coefficients. But, since the optical constants show extremely small change in the visible spectrum, the transition must take place in that region of shorter-wave red lying between $0{\cdot}7\,\mu$ and $8{\cdot}85\,\mu$. G. E. A.

REFERENCES.

865. *Calculation of the Pressure of a Gas by Aid of the Assumption of a Canonical Ensemble.* **O. Postma.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 781–784, April 22, 1909.)—A mathematical treatment based on Gibbs' statistical mechanics.

866. *General Formula for Saturated Vapours.* **O. Pilling.** (Phys. Zeitschr. 10. pp. 162–168, March 1, 1909.)—A mathematical paper, in which a number of complicated formulæ are derived. T. H. P.

SOUND.

867. *Optical Examination of Periodical Pressure-variations and their Fourier Analysis.* **F. F. Martens.** (Deutsch. Phys. Gesell., Verh. 11. 3. pp. 68–71, Feb. 15, 1909. Physikal. Inst. d. Hochschule, Berlin.)—Fröhlich, Hartmann-Kempf, and the author have previously made visible the vibrations of a telephone membrane by means of a mirror applied in the plane of the membrane. This method, however, had a disadvantage, in that the mirror turned not only about the tangential axis as wished, but also about the radial axis which caused the projected spot of light to execute a complicated curve. This drawback is obviated in the author's present arrangement by setting the plane of the mirror perpendicular to that of the membrane, and so that the normal to the mirror is practically parallel to the radius of the membrane through the mirror's point of attachment. So now any turning of the mirror about a radius as axis has no effect on the reflected beam. A Fourier analysis with 36 points to the period is also indicated by formulæ and the results exhibited in tables. E. H. B.

868. *Material of Wind Instruments and Tone Quality.* **D. C. Miller.** (Science, 29. pp. 161–171, Jan. 29, 1909. Paper read before the Amer. Assoc. for Advancement of Science, Dec. 29, 1908.)—After reviewing the opinions of various authorities on the possible influence of material of wall of wind instruments on their tone quality, the author proceeds to describe his own tests on the question. These fall into two classes—those with a zinc organ-pipe surrounded by a water jacket, and those with flutes of various materials including wood, hard rubber, glass, brass, German silver, silver and gold. He is convinced that the gold flute is distinctly superior, and describes its tone as full and rich, also less shrill when sounded loudly, and more liquid ; the silver flute being more delicate and simpler in quality, becoming, however, shrill in loud and high tones. He considers that for fine tone quality, mere massiveness of the walls is not sufficient, a heavy tube obtained from thick walls of brass, has such increased rigidity as to produce an undesirable result. The walls must be thin, soft, and flexible, and be made relatively massive by increasing the density of the material. He hopes to try a flute of platinum. E. H. B.

REFERENCES.

869. *Resonance Box.* **K. Aichi.** (Mathematico-Physical Soc., Tōkyō, Proc. 4. 20. pp. 396–397, Oct., 1908.)—This paper discusses a previous one by Terada on the reduced length of a circular pipe with large flange and an obstructing plane. In this calculation the magnitudes of the flange and plane were put out of consideration. The effect of this omission is dealt with generally and in several special cases. E. H. B.

870. *Graphical Study of Ancient Musical Instruments.* **Marage.** (Comptes Rendus, 148. pp. 709–711, March 15, 1909.)—An examination (by the author's graphic records of vibration) of obsolete musical instruments. The scales are thus found and recorded for a trumpet, a flageolet, and several flutes. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

871. *Observations of Atmospheric Electricity in Samarkand.* **E. Leyst.** (Soc. Imp. Nat. Moscou, Bull. 4. pp. 493–528, 1907.)—The object of this expedition was to study atmospheric electrical phenomena during the total eclipse of the sun of Jan. 14, 1907, which was visible in Samarkand. Unfortunately meteorological conditions on the day of the eclipse were unfavourable, and the main interest of the results centres in the general electric phenomena observed in this very continental situation. Observations were made at Obrutchewo (40° 5′ N., 68° 34′ E.) on Jan. 9 and 10, and at Lomakino (40° 4′ N., 68° 14′ E.) from Jan. 11 to 14. The observations were directed to measurements of potential gradient, dissipation, ionisation, and the amount of radio-active emanation in the air. *Potential Gradient.*—A benzine lamp was used as collector, and the electrometer was capable of measuring a gradient of 7 volts per m. As a general rule the gradient was so small that no measurement was possible. Only 7 measurements were obtained; these show values varying up to + 56 volts per m. *Dissipation.*—The values found for a_+ and a_- (the percentage loss per min.) were very variable and much larger than those hitherto found in other parts of the world. On the days preceding the eclipse the values vary up to $a_+ = 10{\cdot}22$ and $a_- = 15{\cdot}36$. On the day of the eclipse similar high values were observed before the eclipse began. 25 min. after totality the extraordinary high values $a_+ = 111{\cdot}08$ and $a_- = 138{\cdot}27$ were observed. A heavy snowstorm began about the same time, and the high dissipation may be attributable to the meteorological conditions rather than to the influence of the eclipse. *Ionisation.*—The values found were also higher than those met with elsewhere. The extremes observed were as follows: Maxima $I_+ = 1{\cdot}970$, $I_- = 1{\cdot}156$; minima $I_+ = 0{\cdot}520$, $I_- = 0{\cdot}314$. The figures indicate the number of electrostatic units per $m.^3$ of air. On the day of the eclipse (totality from 10h. 2m. to 10h. 4m.) the following values were obtained: I_- at 9h. 23m., 0·728; at 9h. 35m., 1·026; at 9h. 51m., 0·622; at 10h. 56m., 0·718. I_+ at 9h. 31m., 0·987; at 10h. 19m., 0·981; at 10h. 29m., 1·333; at 11h. 9m., 1·970. *Emanation.*—Owing to experimental difficulties no satisfactory results were obtained from these observations.

R. G. K. L.

872. *Atmospheric Radio-activity in California and Colorado.* **F. A. Harvey.** (Phys. Rev. 28. pp. 188–216, March, 1909.)—The paper describes the results of experiments made at Berkeley, California, and Denver, Colorado, on the amount and character of the emanation collected by a negatively charged wire. Special attention was devoted to determining the percentage of thorium emanation present. The rate of decay of the activity of the collected emanation was determined in the ordinary manner, and by comparing this with the known rates of decay of radium and thorium emanation the percentage of thorium emanation present was determined; 26 observations were made at Berkeley and 9 at Denver. The results show (1) that the half period of decay varied from 30 min. to 5¼ hours, corresponding with a variation in the amount of thorium-excited activity from 10·6 to 76·0 per cent. of the total. (2) Percentages of thorium-excited activity depend on the following: (*a*) A wire exposed at low potential (— 500 volts) collects a much larger proportion than one exposed at high potential (— 5,000 volts); (*b*) the percentage is very sensitive to barometric change, being much decreased when the barometer is rising rapidly; (*c*) west wind is accompanied by the largest percentage, indicating that the air over the Pacific Ocean, off San Francisco, contains thorium emanation, or that the tidal marshes over which the wind comes have an unusually high percentage of thorium salts. [Pacini, Abstract No. 682 (1908), has found that over the Gulf of Liguria the sea air contains practically no thorium emanation.] (3) At Berkeley the greatest amount of active material was collected with a north wind. This is connected by the author with a large area, covered by volcanic springs, situated about 180 miles north of Berkeley. (4) Nearly half the ionisation produced by the deposit was found to be due to α-rays having a range of between 2·7 and 3 mm. in air under ordinary conditions of temperature and pressure. These particles are traced mainly, if not entirely, to radium B. R. G. K. L.

DISCHARGE AND OSCILLATIONS.

873. *Photo-electric and Actino-dielectric Action in Phosphorescent Alkaline Earths.* **P. Lenard** and **S. Saeland.** (Ann. d. Physik, 28. 3. pp. 476-502, March 2, 1909.)—Electrometer measurements with phosphorescent material are often difficult to carry out, as many phosphorescent substances are good insulators, and they assume, when the photo-electric effect begins, a positive charge, which neutralises the effect of the externally applied field. This is not caused by a positive charge over the whole surface of the "phosphor" (phosphorescent substance), but can be explained by the assumption that the photo-electric effect is confined to molecular groups or "centres," which consist of atoms of the active metals which are also the centres of absorption of the active light rays. These centres assume the positive charge and produce local fields as a result of excitation of the phosphor by light or kathode rays, and the effect is called the electric polarisation of the centres. Electrons are thrown off from the metal atoms of the centres and light-emission takes place during the return of the electrons, and while at least one of these is wanting in the metal atom. This mode of representing the action explains the peculiar temperature conditions of phosphorescence bands and also Stokes' rule. Another effect on phosphors, chiefly produced by red light and called the actino-dielectric effect, which takes place when they are illuminated in an electric field, is also described. G. E. A.

874. *Doubly-charged Ions in a Gas.* **J. Franck** and **W. Westphal.** (Deutsch. Phys. Gesell., Verh. 11. 6. pp. 146-154, March 30, 1909. Physikal. Inst. d. Univ., Berlin, March, 1909.)—Townsend has shown that positive ions carrying a double atomic charge are sometimes generated when the ionisation is produced by Röntgen rays, while the negative ions always carry unit charge [see Abstract No. 518 (1909)]. Zeleny's method in a slightly modified form, so as to avoid recombination of the ions produced, is here used for finding their rate of motion. The diffusion coefficient is measured by a method which is the same in principle as that first made use of by Townsend. The results obtained show that when ionisation is set up by Röntgen rays positive ions carrying a double charge are generated. These positive ions with double charges form about 9 per cent. of the total number of positive

ions present. It appears probable that a small number of still more highly-charged ions are also produced. The ions with double charges can be separated from those with a single charge by a kind of "fractional diffusion." The rate of motion of the ions with double charge is the same as that of those carrying unit charge, and their coefficient of diffusion is half as great. Also e/m is the same for both kinds of ions, so that the double charge is attached to a double mass. The law that the rate of motion of the ions depends only upon the gas containing them, and not on the nature of the primary nucleus, is confirmed. A. E. G.

875. *Occlusion of Residual Gas in Vacuum Tubes and the Formation of Gas-bubbles in the Glass Surface.* **R. Pohl.** (Deutsch. Phys. Gesell., Verh. 11. 6. pp. 155–160, March 30, 1909. Physikal. Inst. d. Univ., Berlin, March, 1909.) —The author attacks the mechanical theory of the occlusion of residual gas and the formation of bubbles in the glass as put forward by A. A. Campbell Swinton [see Abstracts Nos. 1887 (1907) and 520 (1909)]. He states that the later researches of Swinton seem rather to prove the truth of the theory depending upon the chemical origin of the bubbles formed, for it is difficult to conceive the nature of the accelerating force which confers on the hydrogen the necessary velocity to enable it to penetrate the material. It is, on the other hand, quite easy to account for the effects observed with electrodeless discharge by assuming the impinging electrons to bring about an alteration in the glass surface. In an experiment Na-amalgam heated to 300° forms the anode; a glass tube filled with nitrogen at several mm. pressure is immersed in this. The kathode is of Pt, and the p.d. used is 1,000 volts. The separation of metallic Na in the upper layers of the glass causes a formation of bubbles similar to those caused by Al. They differ from the latter in that they are only half as large and penetrate to a much less depth, as in the case of the electrodeless discharge of Swinton. So it appears that the surface decomposition of the glass owing to the chemical action of the kathode rays seems a probable explanation of Swinton's experiments. A. E. G.

876. *Existence of Positive Electrons in Vacuum Tubes.* **A. Dufour.** (Comptes Rendus, 148. pp. 481–484, Feb. 22, 1909.)—A criticism of a paper by J. Becquerel upon the existence of positive electrons [see Abstract No. 1463 (1908)]. The author points out that the observations were only those of canal rays which were produced in a somewhat different manner from the usual. **J. Becquerel.** (Ibid. pp. 546–548, March 1, 1909.)—Becquerel upholds the conclusions drawn in his first paper [*loc. cit.*] basing his opinion mainly upon the fact that he finds it possible to deviate the bundle of rays in his experiment without displacing the kathode rays at all. **A. Dufour.** (Ibid. pp. 622–625, March 8, 1909.)—Dufour establishes the truth of his contention put forward against the view of Becquerel that the deviable rays were due to positive electrons. By the use of a movable kathode a change in direction of the kathode rays was obtained at will, and it was then noted that the Becquerel bundle of rays was always deviated in the opposite direction, and this without any magnetic field at all. E. C. C. B.

877. *Reflection and Secondary Radiation of Slow Kathode Rays.* **O. v. Baeyer.** (Phys. Zeitschr. 10. pp. 176–182, March 1, 1909. Paper read before the 80. Naturforscherversamml., Köln.)—This paper is an account of the continuation of researches on slow kathode rays. The earlier investigations have already been described [see Abstract No. 848 (1908)]. The

present paper describes the measurement of the reflection of the bundle of kathode rays by the method of Faraday's cylinder, and also gives an account of the influence of the material on the reflection and secondary radiation. In agreement with the author's earlier work it was established that there exists a considerable reflection as well as a secondary radiation for kathode rays which proceed from a glowing oxide kathode with primary velocities of 5 volts and upwards at the surface of metal plates. The reflection decreases with increasing primary velocity, the secondary radiation increases. The secondary radiation is so intense that already, with a primary velocity of about 5 volts, as many electrons leave the plate as fall upon it. The nature of the surface of the reflector has an essential influence on the phenomenon, whilst any influence due to the material has not been proved with certainty. Soot and platinum black show reflection and secondary radiation in only quite a small degree. J. J. S.

878. *The Carriers of the Positive Charges from Hot Wires.* **J. J. Thomson.** (Cambridge Phil. Soc., Proc. 15. p. 64, Feb. 23, 1909.)—The carriers of the positive charges have about 27 times the mass of an atom of hydrogen, and seem to be molecules of CO (not nitrogen). The carriers of the positive electricity given out by hot metals are for the most part the molecules of gas absorbed by the metal. [See also Abstract No. 1134 (1908).] A. D.

879. *Magneto-Kathode Rays.* **Gouy.** (Comptes Rendus, 148. pp. 681–684, March 15, 1909.)—The emission of parasitic rays by the electrified sides of a bulb often disturbs the observation of the magneto-kathode and magneto-anode phenomena [see Abstract No. 686 (1909.)]. This is remedied by placing in the bulb a metallic girdle in the form of a cylinder with its axis perpendicular to the magnetic field. The electrodes are placed in this hollow cylinder, and are thus shielded from rays emitted by the glass. The part played by the magneto-kathode rays in the passage of the current through the bulb is examined, and it is found that when there are several anodes, one set A receiving the rays, the other set B not receiving any, nearly all the current passes by way of A. This effect is produced with all degrees of vacuum in which the rays can be obtained. The resistance of the gas is tested when the sounds are placed (*a*) in the path of the rays, (*b*) outside the rays, and (*c*) when no magnetic field is applied. The results obtained show that the resistance is least in the first case and greatest in the second. When a diaphragm is placed in the bulb so that the current has to pass by a small aperture there arise what are known as magneto-kathode striction rays. The great value of the potential gradient at the opening is undoubtedly the cause of this, and the same explanation will apply to those magneto-kathode rays which sometimes arise at the magneto-anodic crown when that is the seat of a considerable fall of potential. These rays are very often scarcely visible, but under favourable circumstances they form a complete bundle, having the appearance of a hollow tube starting from the most luminous part of the crown. A. E. G.

880. *The Mercury-vapour Spark-gap.* **B. Glatzel.** (Deutsch. Phys. Gesell., Verh. 10. 13. pp. 464–472, July 15, 1908. Jahrbuch d. drahtlozen Telegraphie, 2. 1. pp. 65–91, Oct., 1908.)—An account of further experiments in connection with the "impact excitation" method previously described [Abstract No. 668 (1908)], which has been claimed as his own by Rendahl [Abstract No. 1856B

(1908)]. The chief points investigated are (1) whether it is possible to obtain both coupling waves under certain conditions instead of only the fundamental; and (2) whether the damping increases with the closeness of the coupling. As regards (1) it is found that with very close coupling ($k = 0·298$), when the author's arrangement for changing the discharge potential was used [*loc. cit.*], the two waves were actually obtained, probably owing to a relighting of the gap. (2) The decrement of the gap circuit increased from 0·36 at $k = 0·008$ up to 0·58 at $k = 0·188$. L. H. W.

881. *Measurement of High Pressures and Determination of Spark-potentials for Large Sparking Distances.* **C. Müller.** (Ann. d. Physik, 28. 3. pp. 585–620, March 2, 1909. Extract of Dissertation, Berlin.)—The direct measurement of direct-current pressures above 100,000 volts is attended with great difficulty owing to leakage causing fluctuations in the potential. However, the author finds that by using well-insulated conductors and enclosed Leyden jars a single influence machine with large plates is capable of giving a constant pressure up to 140,000 volts. In considering the various methods of measuring these high pressures he finds that Warburg's relation for the point-discharge, $i = AV(v - v_0)$, holds for high pressures up to 42,000 volts. For direct comparison of pressures up to 140,000 volts the electrostatic electrodynamic balance of Crémieu may be used if its construction is modified, but over the range 3,000–100,000 volts the author has used a convenient form of accurate pointer electrometer capable of measuring over four ranges. He has measured the spark potentials between plane surfaces and between spheres of 2 cm. and 5 cm. diam. respectively. For uniform fields he finds, in the case of plane surfaces, an almost linear increase of the discharge potential with the sparking distance, the values being in good agreement with those obtained by Liebig (Phil. Mag., 1887) for smaller sparking distances. In the case of spherical electrodes it is noticeable that the curve of discharge potentials is quite similar in shape to that obtained by Heydweiller for spheres of radius 0·25 cm. W. C. S. P.

882. *Diffraction of Electromagnetic Waves by an infinitely long Cylinder of Dielectric.* **C. Schaefer.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 11. pp. 326–345, 1909. Phys. Zeitschr. 10. pp. 261–271; Discussion, pp. 271–272, April 15, 1909.)—In the mathematical treatment of the diffraction of electromagnetic waves by conducting cylinders it has in general been necessary to exclude the influence of the material of the cylinder. In those few cases in which it has been possible to allow for the influence of the material the theoretical conditions cannot be realised experimentally. The author of this paper therefore develops theory for the case when the conducting cylinder is replaced by a cylinder of dielectric. The theory shows the effect of the dielectric-constant of the dielectric, and the theoretical conditions are experimentally possible. The mathematical part of the paper cannot be abstracted. The theoretical results are as follows: (1) Directly in front of the cylinder there are interference bands. The position and intensity of these depend on the dielectric-constant of the cylinder and on the ratio of radius of cylinder to the wave-length. (2) Directly behind the cylinder we may have, according to the dielectric constant, radius and wave-length, (*a*) an increase of intensity, which gradually falls off with increasing distance; or (*b*) a "shadow," which may deepen to a maximum at a particular distance from the cylinder and then gradually vanishes, or (*c*) an increase of intensity

which gradually changes over to the shadow (*b*). Experiments are carried out to test the theory with waves of 24 cm. and 58 cm. length, the dielectric used being water. The results agree in general excellently with the theory. Irregularities are due to the fact that the theory supposes the waves to be undamped, and also the resonator has a disturbing effect, especially when near the oscillator. T. P. B.

883. *Diffraction of Hertzian Waves.* **H. Poincaré.** (Comptes Rendus, 148. pp. 812–817, March 29, 1909.)—The author continues his investigation [see Abstract No. 691 (1909)]. The Fredholm equation obtained is—

$$2\pi\mu = \int \mu' K \partial\sigma' + N,$$

where μ is the electric density at a point M of the surface of the conductor; the integration is taken over the various elements $\partial\sigma'$ of the surface, μ' being the density at the centroid M′ of the element $\partial\sigma'$, K is a function of the coordinates M and M′, and N is the component normal to the conductor of the electric field due to exterior sources. The case of a sphere the radius of which is very great compared with the wave-length is considered. The exterior action is supposed to be due to a single exciter at a point S distant D from the centre O. Isochronous oscillations are supposed set up of such a nature that the quantities are proportional to $\epsilon^{\iota\omega t}$. In this case—

$$4\pi N = \epsilon^{\iota\omega(t-r)}\left\{\frac{\iota\omega}{r}\sin\theta\sin\xi + \left(\frac{1}{r^3} + \frac{1}{\iota\omega r^3}\right)\sin\theta\sin\xi + 2\cos\theta\cos\xi\right\};$$

r is the distance SM and θ, ϕ and π-ξ represent the angles S, O, and M of the triangle SOM. When ω is great and r is not very small we can neglect the last two terms in the bracket. N is then developed in a series of Legendre coefficients—

$$N = \Sigma K_n P_n, \text{ and } \int_0^\pi P_n N \sin\phi\,\partial\phi = \frac{2K_n}{n+1}.$$

K_n is of the form $A_n J_n(\omega\rho)/\rho^3$, where J_n is analogous to a Bessel's function and is a solution of an equation of the form—

$$\partial^2 y/\partial x^2 + y[1 - n(n+1)/x^2] = 0.$$

Writing J_n and I_n for the two solutions of this equation, the latter of which equals $\epsilon^{-\iota x}$ when x is very great, we obtain—

$$\mu = A\Sigma\frac{K_n P_n}{I_n'(\omega\rho)J_n(\omega\rho)}.$$

Assuming ω to be very great, the author finds an approximate formula. He shows that μ/N is of the order—

$$1/\sqrt[4]{\omega}\ \sqrt[4]{1 - 1/D^2}.$$

We see that the value of this fraction diminishes as ω increases, and increases the nearer the source is to the sphere. This explains the astonishing effects obtained in long-distance wireless telegraphy. A. R.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

884. *Electrical Properties of Selenium.* **V. Chiarini.** (Accad. Lincei, Atti, 18. pp. 246–258, March 7, 1909.)—Selenium sublimes in two forms, a black granular variety when the condensing surface is inside the vessel in which the selenium is boiled, and a reddish crystalline variety when the condensing surface is outside. Both, when placed between two metals, exhibit electrolytic conductivity, the p.d. ranging from 0·02 to 0·9 volt, and being greater, for similar conditions, with the red form. Couples made with sublimed selenium are sensitive to light, those with red selenium being the more so; the latter are also affected more rapidly as the intensity of light increases than as it decreases, while the contrary is the case with black selenium. The black deposit, when heated in an oven to 180° for at least 4 hours and gently cooled, assumes a lead-grey crystalline appearance; it is still an electrical conductor, but no longer electrolytic either in the light or dark. Couples formed with such selenium, as well as those with the "soft" or "hard" selenium of Ruhmer, and the ordinary crystalline selenium, become active under the influence of electromagnetic waves, while metal discs covered with crystalline selenium possess a one-sided conductivity from the metal to the selenium. These phenomena do not appear to be of thermo-electric origin, but due to a species of separating power which the system, made up of the metal to which the selenium adheres and the special transformed selenium, has for the two kinds of ions. W. H. Si.

885. *Resistance of Bismuth and Nickel to Continuous Currents.* **F. C. Blake.** (Ann. d. Physik, 28. 3. pp. 449–475, March 2, 1909. From the Bosscha Laboratory.)—An amplified account [see Abstract No. 1693 (1907)] of a research on the effect of temperature and transverse magnetisation on the resistance of Bi and Ni to continuous currents. The results are expressed in groups of curves which exhibit the resistance ratio R/R_0 as a function of the temperature in constant fields, and as a function of the field at constant temperatures, and the variation of the field with temperature for constant values of the resistance ratio from 1 to 35. G. E. A.

886. *Action of Ultra-violet Light on False Equilibria.* **Mme. H. Baudeuf.** (Journ. de Physique, 7. pp. 675–692, Sept., 1908.)—The ultra-violet light was allowed to act on metallic plates placed in an electric field; the author considers the photoelectric phenomena observed to be comparable with those of false equilibria in chemistry. Under the action of ultra-violet light a conductor may be charged positively and may then preserve indefinitely a constant potential; there is thus an essential difference between the action of ultra-violet light and that of other causes (Röntgen rays, gas flames, &c.) which make air conducting. D. H. J.

887. *Electrical Properties of Aluminium.* **H. Pécheux.** (Comptes Rendus, 148. pp. 627–628, March 8, 1909.)—Three specimens of Al were examined with the object of finding the effect of impurities on the thermo-electric properties and on the resistivity of the metal. The specimens contained Fe (0·25 per cent. or less), Si (0·12 per cent. or less), and carbon also in slight traces. The Al was combined with Cu, and the Al-Cu couple heated in a bath and the temperature of the hot junction raised from 0° to the fusion-point of Al (650° to 655°). The thermo-e.m.f.'s were observed by

noting the deflections of a Deprez-d'Arsonval galvanometer. It was found that the presence of Fe raised the value of the thermo-e.m.f., and the effect of Si was the same. The curves obtained were approximately parabolas. While the curves were nearly the same in three cases up to 400°, beyond that temperature they distinctly separated. The effect of the presence of Fe and Si in Al on the *resistivity* is to raise this constant, and the principal temperature-coefficient is higher in proportion to the increase of the impurities in the Al. The observation of the thermoelectricity and the resistivity of Al serves as a sure method of testing the purity of the metal. J. J. S.

888. *Electromotive Force of Magnetisation.* **V. Posejpal.** (Comptes Rendus, 148. pp. 711–714, March 15, 1909.)—The author finds that the e.m.f. of a thermoelectric pile changes when an intense magnetic field is excited in the neighbourhood of the junctions. This change is not connected with the presence of any ferromagnetic metal, and is independent of the direction of the field. This might be supposed to be a new e.m.f., but the experiments have not yet established its existence in the case of absolute uniformity of temperature. This e.m.f. increases with the field but not proportionally, and in the case of FeCu appears to show a maximum. Its direction is usually opposed to the purely thermoelectric e.m.f. when the hot junctions are in the field, but not when the cold junctions are in. The contrary seems true for CuZn in weak fields. With fields from 4,000 to 10,000 the experiments show that $(E_{FeCu} + E_{CuZn} + E_{ZnFe}) = 0$. E. H. B.

889. *Simple Formula for the Self-inductance and the Time-Constant of a very Long Coil.* **M. Deprez.** (Comptes Rendus, 148. pp. 817–818, March 29, 1909.)—If a be the length of the coil the self-inductance is given by l^2/a, where l is the length of the wire. The time-constant L/R is given by kS'/ρ, where k is the ratio of the cross-section of the wire to that of the square circumscribing the cross-section of the insulated wire, ρ the volume resistivity, and S′ the area of the annular zone occupied by the wire at the flat ends of the coil. A. R.

890. *Influence of Pressure on the Thermoelectric Position of Mercury and K-Na Alloy.* **H. Hörig.** (Ann. d. Physik, 28. 2. pp. 371–412, Feb. 4, 1909. Abstract of Inaug.-Dissertation, Leipzig, 1908.)—Previous investigators have made experiments on the thermoelectric behaviour of mercury at various pressures, but the author has extended the observations to higher pressures and to other metals. An elaborate account of his work is given, of which the following is a summary: A thermoelement 70 cm. long made of Pt wire 4 mm. thick and of a mercury column 2 mm. in diam. showed for $\Delta t = 150°$ an e.m.f. of about 10^{-6} volt per degree increase of temp., the direction of the current being Hg⟶hot junction⟶Pt. If this element was subjected at $\Delta t = 150°$ to a pressure transmitted by oil, it exhibited per degree Δt and per kg./cm.^{2} pressure a change in its e.m.f., as measured by a galvanometer, of $2{\cdot}18 \times 10^{-10}$ volt. The direction of the current due to this pressure effect was in the opposite direction to the ordinary thermo-current and was Pt⟶hot junction⟶Hg. Up to $p = 1{,}400$ kg./cm.^{2} there could not be proved (within the limits of error) any departure from proportionality to pressure. The probable error of the number 2·18 might be about 1 per cent. Considering the value of the pressure effect found by E. Wagner for Pt the number obtained by the author for Hg agrees well with that given by Wagner. A

quite analogous thermoelement formed from K-Na alloy from Merck was subjected to the same temperature and pressure conditions. Its (ordinary) thermoelectric e.m.f. showed a parabolic course and gave for $\Delta t = 150^\circ$ about $5 \cdot 10^{-6}$ volt per degree increase of temperature. The direction was: K-Na ⟶ hot junction ⟶ Pt. The pressure effect measured under the same conditions as with the Hg-element gave per degree Δt and per kg./cm.^{2} pressure the value $2 \cdot 18 \times 10^{-10}$ volt. In this case also the direction of the current produced by this pressure effect was opposite to the ordinary thermo-current, being in the direction: Pt ⟶ hot junction ⟶ K-Na. As in the former case, up to $p = 1{,}400$ kg./cm.^{2} no departure from proportionality to pressure could be proved. The probable error of the number 2·18 may be taken as roughly 8 per cent. J. J. S.

891. *Conduction of Electricity.* **J. Koenigsberger.** (Zeitschr. Elektrochem. 15. pp. 97–105, Feb. 15, 1909.)—It is generally recognised that electricity is carried, in the case of fused or dissolved salts, by *ions*, and in metals and in kathode-rays by *electrons*; the method of conduction in non-metallic elements, in solid compounds and in many liquids and gases has been regarded as uncertain. The following criteria are suggested: (1) *Transport of matter and separation of electrolytic products.* The passage of 8,600 coulombs through PbS, Fe_2O_3, Fe_3O_4, FeS, FeS_2, BaO, $KAlSi_3O_8$ never gives so much as 5 mgm. of electrolytic product, whilst crystalline $BaSO_4$ soon produces a roughening of the electrodes, and a sulphate reaction can be detected by suitable methods. If in the first series of compounds electrolysis is to be assumed, a reverse polarisation current must be postulated 10,000 times stronger than in water or in fused salts: no evidence of this is to be found in crystals of barium sulphate, and the assumption is very improbable. It was also possible that the conduction, though electronic or metallic in character, might be due to particles of free metal present as impurity in the oxide or sulphide: this assumption is rendered improbable by the fact that perfectly clear crystals of quartz show some degree of metallic conduction, and that in the case of lead sulphide it would be necessary to assume the presence, in all samples, of a constant quantity of free lead amounting to no less than 2 per cent. As a matter of fact, suspended metal is not capable of producing metallic conduction, even when present up to 25 per cent. of Na or K in solid NaOH or KOH, or Pb as a cloud in solid $PbCl_2$; iron powder suspended in paraffin does not cause conduction and metal suspended in fused salts does not disturb Faraday's law. The conclusion is therefore drawn that the compounds themselves show genuine metallic conduction. (2) *Polarisation.*—This can readily be detected in barium sulphate at low temperatures when the resistance is a millions ohms, and is but little affected when the resistance is reduced in the ratio 1:10,000 by raising the temperature 800°. But no polarisation can be detected in pure adular, $KAlSi_3O_8$, up to 1,070°, although 0·0001 volt could be detected; great care is needed, however, to avoid thermoelectric effects. (3) As a rule substances which dissolve in water to form electrolytic solutions show electrolytic conduction in the solid state, whilst those which are in insoluble or only form colloidal solutions show metallic conduction. (4) Homogeneous metallic conductors show a minimum resistance at some temperature, high or low, whilst *homogeneous* electrolytes show a continuous increase of conductivity with temperature (*composite* electrolytes, however, give a minimum resistance or maximum conductivity). (5) Metallic conductors show a continuous absorption and emission, whilst electrolytic salts, whether solid or liquid, show only selective absorption in the ultra-violet and ultra-red. The relation between conductivity and temperature in metallic conduction, from which by means of van't Hoff's equation the energy of dissociation of the electrons from the metal can be deduced, is also discussed. The values deduced for these heats of dissociation are for the metals of the sodium and calcium groups below 100, for hydrogen above 500 for carbon in graphite and silicon 700 and 600, for the heavy metals below 20, for the non-metals well above 1,000. The values deduced for compounds are Fe_2O_3, 2,600; FeS_2 (pyrites), 480 (marcasite) 1,850; FeS, 1,500; Fe_3O_4, 1,600; SnS, 4,000; PbS, about 100; MoS, 2,800; CuO, 12,000; Cu_2O, 5,000; SiO_2, 22,000; AgS_2, 11,200. The limit for metallic conduction appears to be about 40,000, above which electrolysis is more likely to occur. T. M. L.

892. *Drying Power of Electric Endosmose.* **W. Nernst.** (Deutsch. Phys Gesell., Verh. 11. 5. pp. 112–117, March 15, 1909. From the Inst. f. physikal. Chemie an d. Univ., Berlin.)—When a damp, porous earthenware plate is provided with two grating electrodes, as soon as a suitable e.m.f. is applied to the latter the top positive surface becomes dry and water oozes out from the under surface. The force brought into play is too small, however, to extract water from organic cells, and experiments made by Brill show that the forces due to electric endosmose probably suffice to remove free water, but do not have a thorough drying action, and the term endosmotic drying should therefore be avoided. By assuming a certain difference of vapour-pressures at the two sides, the work done in drying is found to be only about 2 per thousand of the electric energy spent. G. E. A.

893. *Cadmium Cell at 0° C.* **E. Cohen** and **H. R. Kruyt.** (Zeitschr. Phys. Chem. 65. 3. pp. 359–370, Jan. 5, 1909. Van't Hoff-Laborat., Utrecht.)—Jouaust obtained anomalous results at 10° C. with 10 per cent. cadmium amalgam as the negative pole of the Weston (cadmium) normal cell, but with 12·5 per cent. amalgam regular results were obtained [see Abstract No. 1682 (1908)]. The authors deemed it important to see whether the phenomena described by Jouaust were natural or whether they should be treated as occasional occurrences. Six cells of the type—

Cadmium amalgam 10 per cent.	Unsaturated cadmium sulphate solution.	Cadmium amalgam 12·5 per cent.

were constructed, and after one month the measured e.m.f.'s at 0° C. were 0·04, 0·23, 0·18, 0·16, 0·20, and 0·20 millivolts respectively, the 12·5 per cent. amalgam being positive. One of the 2 poles, or both, is not a two-phase system; consequently the concentrations are different, and it therefore follows that there must be a p.d. For cells to be used at 0° C. an 8 per cent amalgam appears to be suitable. Jouaust's idea that at 0° C. a 12·5 per cent. amalgam is preferable to a 10 per cent. one is refuted. F. E. S.

894. *Notes on the Plug Permeameter.* **C. V. Drysdale.** (Phys. Soc., Proc. 21. pp. 229–233; Discussion, pp. 233–234, March, 1909.)—The magnetisation curves obtained by the author's permeameter [see Abstract No. 1988 (1901)] were noticed to fall below those obtained by measurement on a long bar of the material. Experiments at that time seemed to indicate that this

was due to the reluctance of the return path at the point of entrance of the flux, due to the concentration of the lines of force at these points. Arrangements were therefore made to see if there was any relation between the true magnetising force H and the apparent magnetising force $H' = 4\pi n C/10l$. Specimens of cast and wrought iron and steel were obtained in the form of rings. They were tested by the ordinary ring method and then each ring was cut into four quadrants, each of the quadrants being drilled to contain the plug at each end. Readings of the induction density were taken by the plug method at nominal values of H of 80 and 100. It was then found that the variations of the induction density at a given magnetising force for a given ring are not due to variations in the fit of the plug, but rather due to actual differences in the magnetic quality of the iron. In every case the magnetisation curve taken on the plug lies below that for the ring; from the appearance of the curves this effect cannot be due to an air-gap. For a given induction density the author has determined from each curve the value of H′ for each value of H. It is observed that the difference between H and H′ is greater in the case of a special cast iron than for either wrought iron or mild steel, a result which is exactly contrary to the effect that would be produced by an air-gap. The difference must therefore be attributed to the shortness of the specimen. If the scale on the permeameter which indicates intensity of magnetisation be now corrected from the mean of the results obtained in the above method, the instrument is found to give results in as good agreement as most recognised permeameters. In the *discussion*, **S. P. Thompson** said that he was not sure that the author's explanation of the discrepancies was correct. In drilling the hole in the casting the magnetic properties of the iron were altered and the hysteresis increased. **A. Campbell** was not surprised that the author had to calibrate his permeameter by comparison with the ring method. **A. Russell** suggested that the discrepancy between the two methods was due to the ring being of appreciable radial depth, the magnetic force on the inner circumference of the ring being about 50 per cent. greater than on the outer, there would be big differences of permeability which would account for the discrepancy. The **Author**, in reply, stated that no variations in the results as obtained by the permeameter were detected after annealing the specimen. In order to permit of drilling it was necessary to have a thick ring, but there would be little error from this cause except at low inductions. W. C. S. P.

895. *An Absolute Torsion Electrometer.* **E. Salmon.** (Soc. Franç. Phys., Bull. 3. pp. 254–261, 1908. Lumière Électr. 6. pp. 52–54, April 10, 1909.)—This is an instrument which by suitable adjustment may be used for absolute measurements from 20 volts to 40,000 volts. The electrometer consists of two metal plates which are placed parallel to each other and vertical in a glass cage. The large plate has attached to its centre a glass arm, by means of which it can be moved in a horizontal direction, the displacements being measured by means of a spherometer. The small metal plate is a light disc of Al and is surrounded by a guard ring. The disc is attached at its centre to one end of a light metal cross balanced horizontally, the whole arrangement being suspended by a fine silver wire which is attached to a torsion head. The guard ring is directly connected to earth. The light needle, to which is attached the Al disc, has wound over it a Pt wire, one end of which comes in contact with the disc and serves to carry a second wire of Pt, which hangs vertically in an earthed vessel containing acid. The small disc and guard ring being connected to earth, the large plate is connected to an

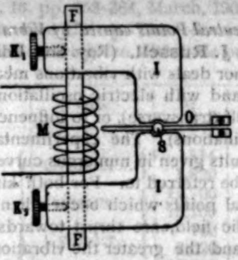
insulated terminal, which is brought to the potential to be measured. Cocoon threads stretched across the inner surface of the guard ring serve to check the motion of the small disc. The law of the instrument being that of the Kelvin attracted-disc electrometer, it follows that, with the plates at a constant distance apart, the voltage will be proportional to the square root of the angle of torsion. It is shown that with plates of 12 cm. diam. the law holds to 1 per cent. up to a distance apart of the plates of 2 cm.; at high potentials the law holds up to 8 cm. Examples are given showing how relative and absolute measurements may be made both of high and low potentials. In order to replace the suspension by a thicker wire for high-potential measurement, all parts of the instrument are movable, the case opening both in front and at the back. W. C. S. P.

896. *Standard Resistance of a New Form.* **E. B. Rosa.** (Bureau of Standards, Bull. 5. pp. 413–434, Feb., 1909.)—Rosa and Babcock have shown [see Abstract No. 123 (1908)] that resistance coils kept in an atmosphere of constant humidity are practically constant in resistance. The coil now described is wound in the usual manner on a brass cylinder 3 cm. in diam. and 7 cm. long, and is contained within a cylinder 4 cm. in diam. and 12·5 cm. high. The coil is shellacked, dried, and annealed in the usual manner. It is supported by a small tube closed at the bottom, which serves as a thermometer tube. The hard-rubber top through which the leads pass is threaded and screws into the outer brass cylinder that forms the case. After adjustment of the coil, the case is nearly filled with pure oil free from moisture, and the top screwed firmly into place, shellac being put into the threads before screwing up. Some curves showing the temperature-coefficients of manganin wires are given, and bridges for intercomparing coils of the same or of different denominations are described. Of 28 sealed standards which have been kept under close observation, only 1 has changed by so much as 2 parts in 100,000 during the past 12 months. Comparisons of resistances at the Bureau of Standards, the Reichsanstalt, and the National Physical Laboratory show that the units of resistance employed at the 3 institutions are identical within 3 parts in 100,000. F. E. S.

897. *Relay driven by Electrostatic Forces.* **K. Bergwitz.** (Phys. Zeitschr. 10. pp. 118–121, Feb. 15, 1909.)—Description of an instrument the essential part of which is a quadrant electrometer the motion of whose needle makes the contact necessary to complete the circuit containing the relay. When used for light-telegraphy with a photoelectric cell, the light falling on the alkali surface of the cell, causes the latter to charge the insulated quadrants and hence to bring the relay into action. [See Abstract No. 1884 (1907).] G. E. A.

898. *Improved Form of Engler-Sieveking Apparatus for determining the Amount of Emanation in Water.* **H. Mache** and **S. Meyer.** (Zeitschr. Instrumentenk. 29. pp. 65–68, March, 1909.)—In the earlier form of apparatus a loss of emanation is occasioned when the electrode is being introduced into the vessel containing the water; this loss is too important to be neglected, and yet it is not possible to calculate the amount so lost. This leakage becomes more considerable when the apparatus is heated as in the examination of the water of hot springs. The new apparatus, of which diagrams and details of construction are given, avoids these sources of error and is much more expeditious. Great care is taken to make the whole apparatus as air-tight as is practicable. A. E. G.

899. *Apparatus for Demonstration of Hysteresis Curves.* **A. Wehnelt.** (Deutsch. Phys. Gesell., Verh. 11. 5. pp. 109–111, March 15, 1909. Physikal. Inst. d. Univ., Berlin, Feb., 1909.)—The specimen, in the form of a cylindrical bar FF (see Fig.), is fixed in a yoke of soft iron II by means of the screws K_1K_2. The yoke has an air-gap O within which is placed a gently stretched bronze strip on which a small mirror S is fixed which can turn about a horizontal axis. A small constant current is passed through the bronze strip. Using an arc lamp as source, the beam is reflected from S on to the mirror of a moving-coil galvanometer, placed close to S; this galvanometer, provided with a suitable shunt is placed in circuit with the magnetising coil. By passing a cyclic current through M, and using the blackboard as a screen, the motion of the spot of light may be traced with chalk and the hysteresis curve drawn. In this way the difference between iron and steel can be demonstrated in a large hall. G. E. A.



ALTERNATING CURRENTS AND MAGNETISM.

900. *Behaviour of a Permanent Magnet for Change of its External Magnetic Resistance.* **P. Gehne.** (Ann. d. Physik, 28. 3. pp. 558–570, March 2, 1909. Extract from Dissertation, Halle, 1908.)—The object of the author's research was to determine what it is that remains constant in the case of a permanent magnet when its external magnetic circuit is changed. Weber has shown [see Abstract No. 827 (1905)] that for field-changes of not more than 15 per cent., and changes in the magnetic resistance the magnetomotive force is constant. Kempken has found [Abstract No. 1920 (1906)], using a split anchor-ring of magnetised steel, that the m.m.f. is constant if the reluctance of the circuit be varied so as to produce change in the air-gap field not exceeding 170 per cent. In the present work the author examines two rings of tungsten steel, one having a circular cross-section, the other being rectangular; a third ring of Remy steel of much larger circular section was also used. The first and last rings were split into halves, and when magnetised the distribution of flux was investigated by the search-coil method. It was found that in the case of the ring of small section there is about 2 per cent. change in the total number of lines of force as the distance apart of the faces is increased to 8 mm.; but in the case of the thicker ring the total flux-change is much more marked, the flux being reduced to about one-half when the air-gaps are 80 mm. long. Further experiments show that the relative change is practically independent of the strength of the permanent magnet. The ring of rectangular section was first examined before it was cut, and from the curves the max. value of the permeability is seen to be over double the corresponding maximum after cutting. The author concludes from his experiments that within wide limits the m.m.f. is constant in a central tube of induction; also that in the central part of a permanent magnetic circuit the internal resistance is constant. The value of this resistance, however, is not such that it can be brought into consideration with any particular value of the permeability. W. C. S. P.

901. *Shift of the Neutral Points caused by Vibrations Superposed on Cyclical Magnetisation in Iron.* **J. Russell.** (Roy. Soc. Edinburgh, Proc. 29. pp. 1–87, 1908–1909.)—The author deals with vibrations mechanically produced in the magnetised material, and with electric oscillations caused either to traverse the magnetic wire itself (transverse), or to influence it by being wound round it (co-directional oscillations). The experimental arrangements are fully described and the results given in numerous curves and tables, for which the original pages should be referred to. For both kinds of vibration it is confirmed that the neutral points which occur when vibrations are superposed upon decreasing cyclic field, are thrust towards the vertical axis the less the cyclic amplitude and the greater the vibrational intensity; and towards the cyclic extremes the greater the cyclic amplitude and the less the vibrational intensity. These experimental results are then discussed, and it is shown that they are not only in harmony with, but a necessary deduction from, the molecular theory of magnetism. The intensity of vibrations superposed at any point will differentiate between molecular groups of various degrees of stability whose molecules have been arrested in their passage from positions of less to positions of greater stability under the conditions. Neutral points, according to this hypothesis, occur where the rotations of the molecules in opposite directions balance, and these positions must be thrust towards the cyclic extreme at which the last reversal of the field change took place the weaker the vibrational intensity. The results of Eccles and of Maurain are reviewed, and are shown to be not necessarily discordant, since it is the intensity of the superposed vibrations (or oscillations) which determines whether the induction will be increased or diminished; and neither of these workers had recognised that the *direction* of the induction change is not independent of the vibrational intensity. As regards electric oscillations, it is confirmed that it is necessary to distinguish between co-directional and transverse oscillations [compare Walter, Abstract No. 1290 (1905)]. The induction changes are the resultant of the irreversible (vibrational) effect, and the reversible (magnetising or demagnetising) effects of the oscillatory current. In this connection Rutherford's method of determining the damping is criticised, in that Rutherford assumes that if the initial phase of the oscillation train be such as to increase the magnetisation of the needles, it will produce no magnetic effect, because the needles are already magnetised to saturation. It is, however, pointed out that while this is true as regards the reversible effect, the irreversible effect opposes the increase and assists the decrease, hence the residual magnetism may fall below its original value. L. H. W.

902. *Magnetism of Iron Compounds.* **Wologdine.** (Comptes Rendus, 148. pp. 776–777, March 22, 1909.)—The temperatures at which chains of particles of iron compounds in suspension in suitable liquids in a glass tube fell asunder in a magnetic field were as follows: Fe_3O_4, 525°; pyrrhotine

(iron sulphide), 300°; nickeliferous pyrrhotine, 300°; Fe$_3$C, 180°; double carbide of iron and tungsten (Fe$_3$C)$_3$(W$_2$C)$_3$, 80°; franklinite, Fe$_2$O$_3$ZnO, 61°; Fe$_3$P, 445°. The loss of magnetism is progressive, hence the agreement with Curie's result 585° for the magnetic transformation of magnetite and Weiss' 320° for pyrrhotine is as good as should be expected. F. R.

903. *Magnetic Behaviour of Cast Iron and Tool Steel.* **B. O. Peirce.** (Amer. Acad., Proc. 44. No. 13. pp. 353–364, March, 1909. Contribution from the Jefferson Phys. Lab., Harvard Univ.)—The following figures are selected from the tabulated results which are given with little or no discussion :—

Material.	Form.	H.	B.	I.	μ.
Soft cast iron	Cylinder...	114	9,950	782	87·3
		1,820	18,170	1,300	10·0
	Isthmus ...	12,700	31,100	1,465	2·5
		15,100	33,650	1,472	2·2
Hard cast iron	Cylinder...	142	7,860	614	55·4
		2,020	16,800	1,176	8·3
	Isthmus ...	10,900	26,540	1,245	2·4
		14,800	30,200	1,226	2·0
Soft Crescent drill rod	Cylinder...	122	13,060	1,030	107·0
		1,798	20,900	1,527	11·6
	Isthmus ...	4,860	24,600	1,570	5·1
		13,150	33,800	1,642	2·6
Soft Stubs drill rod	Cylinder...	132	14,600	1,154	110·6
		1,780	20,800	1,514	11·7
	Isthmus ...	7,900	26,800	1,500	3·4
		17,100	37,000	1,587	2·2
Hard Crescent drill rod	Cylinder...	114	8,600	677	75·5
		1,894	17,000	1,200	9·0
Hard Stubs drill rod	Cylinder...	123	8,600	675	70·0
		1,416	16,250	1,216	11·5
Jessop's tool steel	Cylinder...	110	15,250	1,205	138·6
		1,980	21,600	1,560	10·9

Results obtained with hardened drill rod gave very high values of I, and hence are not given, as this may be due to unequal hardening. F. R.

904. *Magnetic Properties of certain readily liquefiable Gases.* **P. Pascal** (Comptes Rendus, 148. pp. 413–415, Feb. 15, 1909.)—In order to avoid the errors in the measurement of the magnetic susceptibilities of gases dependent on the low values of these constants, the author makes use of liquefied gases for these measurements, the specific susceptibility χ_s at 0° and 760 mm. pressure being calculated on the assumption that the specific susceptibility of a gas is independent of its physical state, especially if its temperature only varies to a slight extent. The following values for χ_s are thus obtained :—

SO_2 — $8{\cdot}5 \times 10^{-10}$
NH_3 — $8{\cdot}5 \times 10^{-10}$
C_2N_2 — $10{\cdot}1 \times 10^{-10}$
N_2O_4 — $11{\cdot}8 \times 10^{-10}$
$CH_3.NH_2$ — $12{\cdot}5 \times 10^{-10}$
CH_3Cl — $15{\cdot}1 \times 10^{-10}$
Cl — $18{\cdot}7 \times 10^{-10}$

Leaving aside chlorine, the only simple gas in the table, and its organic derivative, methyl chloride, it is found that the product of the specific susceptibility and the molecular weight of a gas is a linear function of the number *n* of atoms in the molecule, the relation being expressed very nearly by: $\chi_i \cdot m = -23(5+n)10^{-7}$. [See also Abstract No. 294 (1909).] T. H. P.

905. *Magnetism of Alloys of Magnetic Metals.* **G. Tammann.** (Zeitschr. Phys. Chem. 65. 1. pp. 78–88, Dec. 8, 1908. Communication from Inst. f. physikal. Chemie, Göttingen.)—The following table shows the known compounds of the magnetic metals Fe, Co, Ni, with Si, Sn, Al, Sb, Bi, Mg, Zn:—

$FeSi$	Co_2Si, Co_3Si_2, $CoSi$, $CoSi_2$, $CoSi_3$	Ni_3Si, Ni_2Si, Ni_3Si_2, $NiSi$, Ni_2Si_3
Fe_xSn_y ?	Co_2Sn, $CoSn$	Ni_3Sn_2, Ni_3Sn, Ni_4Sn ?
$FeAl_3$	$CoAl$, Co_2Al_5, Co_3Al_{13}	$NiAl_3$, $NiAl_2$, $NiAl$
$FeSb_2$, Fe_3Sb_2	$CoSb$, $CoSb_2$	Ni_4Sb_5, $NiSb$, Ni_5Sb_2, Ni_4Sb ?
None	None	$NiBi$, $NiBi_3$
—	—	Ni_2Mg, $NiMg_2$
$FeZn_7$, $FeZn_3$	$CoZn_4$	$NiZn_3$

From rough tests, in which the attraction of the binary alloys of the series for a magnetic needle and the temperature of its disappearance were observed, the following conclusions are reached. When a ferromagnetic metal forms a chemical compound, its magnetic property is much diminished, and, in fact, usually practically vanishes. Solid solutions which have a magnetic solvent are magnetic; solid solutions of even a magnetic metal in a non-magnetic solvent are non-magnetic. Usually the presence of another substance in solid solution in a magnetic metal lowers the temperature at which magnetism disappears. As marked exceptions, however, 4 per cent. of Pb raises the critical point of Ni 5°, and 10 per cent. of Si raises the critical point of Ni 600°. Again, Cr, for example, lowers the critical point of Co and of Ni enormously. It does not yet appear possible to draw any conclusions regarding the molecular weights of metals dissolved in the ferromagnetic metals. The magnetic properties of iron depend on molecular structure rather than upon the intermolecular distance. F. R.

ELECTROPHYSIOLOGY AND ELECTROTHERAPEUTICS.

906. *Drault's Arrangement for Utilising both Phases of an Alternating Current in Radiology.* **Béclère.** (Archives d'Él. Médicale, 17. pp. 257–260, April 10, 1909. Paper read before the Soc. de Radiologie médicale de Paris, March 9, 1909.)—The spark coil is provided with two primaries, joined together at one end, and arranged so that alternate phases traverse these alternately but in opposed directions: the resultant effect is the same as if two pulsations of unidirectional current were passed per interval corresponding to one period of the alternating current. A mercury interrupter (working in coal-gas) driven by a synchronous motor effects the necessary interruption of one of the primary windings at the correct instant. To further secure that it is always the same current-phase (direction) which flows through each primary, a polarised form of circuit-breaker is included in the circuit. L. H. W.

REFERENCES.

907. *The Ruhmkorff Coil.* **O. M. Corbino.** (Lumière Electr. 5. pp. 334–347, March 13, 1909.)—A translation of the work referred to in Abstract No. 1892 (1907).

908. *On the Equations of Electrodynamics.* **V. Volterra.** (Accad. Lincei, Atti, 18. pp. 203–211, March 7, 1909.)—A mathematical paper dealing with Hertz's equations.

909. *Present Position of the Radiation Problem.* **A. Einstein.** (Phys. Zeitschr. 10. pp. 185–193, March 15, 1909.)—A mathematical discussion of the views held on the radiation problem by H. A. Lorentz, by J. H. Jeans, and by W. Ritz, the whole being handled on the basis of the electron theory and the retarded potential. [See also Abstracts Nos. 88 and 260 (1909).] **W. Ritz.** (Ibid. pp. 224–225, April 1.) E. H. B.

910. *Planck's Radiation Law.* **J. Weiss.** (Phys. Zeitschr. 10. pp. 193–195, March 15, 1909.)—Mathematical discussion of the above law on the electron theory. E. H. B.

911. *Radiation Phenomena in a System moving uniformly with Respect to the Ether.* **H. B. A. Bockwinkel.** (Archives Néerlandaises, 14. 2. pp. 1–49, 1909.)—A mathematical discussion on the electromagnetic theory, which results in formulæ in accord with others previously found by Kirchhoff and by Lorentz. E. H. B.

912. *Experimental Confirmation of the Principle of Relativity.* **A. H. Bucherer.** (Ann. d. Physik, 28. 3. pp. 513–536, March 2, 1909.)—A fuller account of the important work already dealt with [see Abstract No. 1993 (1908).] E. H. B.

913. *The Law of Induction.* **F. Emde.** (Elektrotechnik u. Maschinenbau, 26. pp. 997–1001, Nov. 15; 1023–1025 Nov. 22; 1074–1076, Dec. 6, and pp. 1119–1121, Dec. 20, 1908.)—A mathematical treatment of certain induction phenomena which are considered as having been hitherto unsatisfactorily explained, including unipolar induction and Hering's experiment [Abstract No. 838 (1908)]. L. H. W.

914. *Electrostatics.* **Ariès.** (Annal. Soc. Sci. de Bruxelles, 33. 1. pp. 1–107, 1908–1909.)—Electrostatics rewritten, on the footing that electrostatic phenomena are occasioned solely by a real flow of electricity in the dielectric between bodies brought to different potentials, just as heat flows in analogous problems of the uniform flow of heat in a conductor. A. D.

915. *Experiments on Artificial Fulgurites.* **(Miss) D. D. Butcher.** (Phys. Soc., Proc. 21. pp. 254–260; Discussion, p. 260, March, 1909.)—An account of experiments made to test an hypothesis put forward by Fiedler to account for the fact that the natural tubes found are of two sorts.

916. *Use of Shunts and Transformers with Alternate-current Measuring Instruments.* **C. V. Drysdale.** (Phys. Soc., Proc. 21. pp. 235–253; Discussion, p. 253, March, 1909.)—[See Abstract No. 938B (1908).]

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

917. *Synthesis of Ammonia from its Elements.* **J. Lipski.** (Zeitschr. Elektrochem. 15. pp. 189–206, April 1, 1909.)—With a view to obtaining a synthetic method of preparing ammonia from hydrogen and nitrogen, the author has studied the dissociation of cerium nitride. At temperatures between 600° and 700° C. the max. pressure of dissociation lies between 34 and 40 cm. Hg. A definite max. pressure, dependent only on the temperature, could not, however, be obtained, owing probably to the formation of a solid solution of cerium in cerium nitride. It was found that the reactions $3H_2 + CeN = CeH_3 + NH_3$ and $N_2 + CeH_3 = CeN + NH_3$ take place smoothly in open vessels and at moderate temperatures without the reaction $3H_2 + 2CeN = 2CeH_3 + N_2$ appreciably occurring. Moisture and oxygen have an injurious action, and after some time the surface of the solid mass undergoes deterioration, but recovers on being left to itself. The most favourable temperature for the formation of ammonia lies between 200° and 300° C., and the amount of ammonia in the gas may easily reach 1 per cent. by volume. A. F.

918. *Production of Ammonia from Atmospheric Nitrogen.* **H. C. Woltereck.** (Roy. Dublin Soc., Proc. 12. 6. pp. 54–59, April, 1909.)—During experiments on the synthesis of hydrocyanic acid made at Hanover in conjunction with Eschweiler, the author noticed that ammonia was produced when dry hydrogen and nitrogen were passed over so-called reduced iron suspended on asbestos fibre at about 500° C. Air and coal-gas and iron oxide, as also the oxides of Bi, Cr, Ni, Co, Cu, Cd, Ag, Pb (especially the first three oxides) likewise give ammonia. The presence of water-vapour is an advantage, and air and steam alone yield ammonia in the absence of coal-gas, but the oxide is better replaced by iron wire gauze in such case. The experiments are made with iron barrels, packed with wire gauze, and air saturated with steam, best at 800° or 850° C.; prolonged contact with the iron decomposes the ammonia. As the oxidation of the wire gauze proceeds the ammonia yield decreases unless the iron oxide be reduced, and coal or peat is hence substituted for the iron, so that the conditions of the experiments are as in the researches of Beilby and Young and L. Mond on the production of power gas. From 40 gm. of peat containing 26 per cent. of moisture and 1·54 of nitrogen (calculated on absolutely dry peat), air, and steam, the author obtained 880 mgm. of ammonia, equivalent to 8 per cent. of ammonium sulphate on the dry peat consumed. In larger iron retorts 10 per cent. of ammonium sulphate was produced, certainly more than would correspond to the nitrogen present in the peat, and this fixation of atmospheric nitrogen by the moist oxidation was confirmed by experiments with pure sugar-carbon. Particulars of the peat furnaces are not given. H. B.

919. *Analytical Investigation of Zirconium Metal.* **E. Wedekind** and **S. J. Lewis.** (Chem. Soc., Journ. 95. pp. 456–463, March, 1909.)—Starting from spontaneously precipitated colloidal zirconium or from salts precipitated by ammonia, the authors did not succeed in obtaining pure zirconium, neither was the oxygen content constant. In analysing, they heat the metal with pure dry chlorine which converts the metal into volatile tetrachloride, $ZrCl_4$, whilst the oxygen compound is left behind as dioxide. Zirconium combines with nitrogen to a nitride and decomposes CO_2 at higher temperatures; both zirconium and carbon burn in oxygen, and their oxides are easily separated in making carbon determinations. Several specimens of the metal were melted in a vacuum electric furnace of Siemens and Halske; the purest metal obtained from de Haen contained 95·55 per cent. of Zr, 11·7 per cent. of this being ZrO_2. H. B.

920. *Nature of Platinum-Lead Alloys.* **N. A. Puschin** and **P. N. Laschtschenko.** (Zeitschr. Anorg. Chem. 62. 1. pp. 84–89, March 11, 1909. Physikal.-chem. Laborat. d. Elektrotechn. Inst. St. Petersburg.)—These alloys have been studied by measuring the p.d. set up between an alloy and a lead electrode in an electrolyte of n-$Pb(NO_3)_2$. The concentration-potential curve shows discontinuities at concentrations corresponding to the compounds Pb_2Pt and PbPt. Since the potential acquired by PbPt is very close to that acquired by pure Pt, the curve can show nothing definite with regard to the existence of Doerinckel's third compound "richer in Pt than is PbPt" [see Abstract No. 1600 (1907)]. Microscopic examination confirms the existence of the compounds Pb_2Pt and PbPt. F. C. A. H. L.

921. *Reduction of Ferric and Chromic Chlorides by means of Calcium.* **L. Hackspill.** (Bull. Soc. Chim. 1. pp. 895–897, 1907.)—When an intimate mixture of calcium and sublimed anhydrous ferric chloride is heated to dull redness in a magnesia crucible enclosed in an iron crucible with a screw-lid, the chloride undergoes reduction to metallic iron. The prolonged action of fused Ca on iron at a temperature above 1,000° does not yield a Ca-Fe alloy, although it is quite possible that Fe and Ca unite together with other metals to form ternary alloys. Calcium reduces chromic chloride at a dull red heat, yielding metallic Cr, but does not alloy with the latter even when kept at about 1,000° for 8 hours. T. H. P.

922. *Silico-Manganese as a Substitute for Ferro-Silicon.* (Mech. Eng. 23. p. 388, March 26, 1909. From Iron and Coal Trades Review.)—Although ferro-silicon has proved of great value to steel makers, its use is attended by grave dangers. The high-grade alloy, if allowed to come in contact with water or a moist atmosphere, gives off large quantities of poisonous and explosive gases. In view of these objections to its use carbide of silicon and silico-manganese have been suggested as substitutes. Silico-manganese is an alloy of Si, Mn, and Fe, and contains only traces of C, P, and other impurities, and does not give off poisonous or explosive gases. It is a powerful deoxidiser and remover of occluded gases from steel. It is a product of the electric furnace, and is made in several grades, containing from 20 to 40 per cent. Si and from 55 to 75 per cent. Mn. It is claimed to be very economical in use, the Si protecting the Mn from oxidation and the loss of the latter being much less than when ferromanganese only is used; further, it contains practically no carbon and is a most valuable means of adding Si and Mn to steel which has to be kept low in carbon. C. O. B.

923. *Basic Reduction of Copper.* **F. Schreyer.** (Metallurgie, 6. pp. 190–197, March 22, 1909. Communication from the Inst. f. Metallhüttenw. u. Elektrometall. d. Kgl. techn. Hochschule, Aachen.)—The author studied the systems: Fe_3O_4—Cu_2S; Fe_3O_4—FeS; FeO—Fe_3O_4; and comes to the following conclusions. In the basic reduction of sulphidic copper ores a portion of the Fe is oxidised higher than FeO—in fact, to Fe_3O_4, with ample oxygen pressure in the blast, or with considerable reduction of pressure to FeO + Fe_3O_4(Fe_4O_5?). FeO is comparatively inactive at high temperatures, but on further oxidation the sulphides are readily attacked. The marked inactivity of a melt of the composition 2FeO + Fe_2O_3 is the only indication that any other compound than Fe_3O_4 exists between FeO and Fe_2O_3. Solutions of sulphides in Fe_2O_3 exist whose melting-points are lower than those of the FeO—Fe_2O_3 mixtures (or compounds), but the melting-point of the mixture corresponding to the claim of Westinghouse, with 5 per cent S, is over 1,300°, and so could not be used favourably in ordinary copper extraction. The use of the basic process appears to be limited, as pointed out by Brandt (Ibid. 2. pp. 334–335, 1905), and, in fact, can probably only be successfully applied to concentrates at higher temperatures, by increasing the oxygen pressure of the blast. F. R.

924. *Occluded Gases in Steel.* **E. Goutal.** (Comptes Rendus, 148. pp. 988–991, April 3, 1909.)—The methods are described by which the author determined the percentage of residual carbon (C_1), carbon evolved as CO_2 (C_2), carbon evolved as CO (C_3), and carbon in the form of gaseous compounds whose exact nature was not determined (C_4), when steels were dissolved in the double chloride of copper and potassium. Three examples are given :—

Steel.	C_1.	C_2.	C_3.	C_4.	Total C.
A............	0·2750	0·0057	0·0051	0·0009	0·2867
B............	0·5960	0·0185	0·0059	0·0171	0·6375
C............	1·3340	0·0216	0·0061	0·0158	1·3775

Thus, working with a slightly acid solution at moderate temperature, and in a current of nitrogen, the loss of carbon in evolved gases would be from 0·01 to 0·05. This loss can be entirely avoided if the solution be boiled after the action is complete, and the evolved gases be passed with excess of oxygen through a tube containing a red hot Pt-wire, and estimating CO_2 with barium hydrate as usual. F. R.

925. *Overheated Nickel Steel.* **E. Heyn** and **O. Bauer.** (Königl. Materialprüfungsamt, Mitt. 27. 1. pp. 1–7, 1909.)—Two pieces of a nickel steel containing 5·5 per cent. Ni and 0·09 per cent. carbon had cracked in forging. The structure was coarse, but refined upon annealing at 900° C. The brittleness of the steel is found to be due to forging at too high a temperature. The upper limit was found to be for one of the pieces 1,085° C. and for the other 1,130° C. The only apparent difference was in the dimensions of the samples, viz., 40 × 55 mm. and 40 × 45 mm. respectively. The duration of heating at the forging temperature is equally of importance. F. R

926. *Composition and Properties of the Salts formed in the Fixing of Silver Bromide and Chloride Gelatine Plates.* **A. Lumière, L. Lumière,** and **A. Seyewetz.** (Bull. Soc. Chim. 1. pp. 946–953, 1907.)—The solution of silver bromide and chloride in 15 or 45 per cent. sodium thiosulphate solution yields double thiosulphates of sodium and silver which are different in the two cases and have not the composition usually attributed to them. The results obtained confirm the danger of using fixing solutions so long that they become saturated with silver haloid, especially silver chloride. T. H. P

927. *Table for Determination of Concentration of Methyl Alcohol from the Specific Gravity at 15°/15°.* **P. Klason** and **E. Norlin.** (Arkiv Kem. Min. Geol., Stockholm, 2. No. 27. pp. 1–82, 1907.)—None of the existing tables connecting specific gravities and concentrations of mixtures of methyl alcohol and water are based on the sp. gr. of absolutely pure, anhydrous methyl alcohol. The table given by the authors is based on the value previously obtained [Ibid. 2. No. 24, 1906] for the sp. gr. of methyl alcohol, and shows the percentage of alcohol by weight and volume and the gm. of alcohol per 100 c.cm. for sp. gravities varying from 0·7964 to 1·0000 by increments of 0·0001. The table may also be employed, without great inaccuracy, for crude methyl alcohol, the results then giving approximately the sum of the contents of methyl alcohol and acetone. T. H. P.

928. *Coefficient of Diffusion.* **B. W. Clack.** (Phil. Mag. 16. pp. 863–879, Dec., 1908. Paper read before the Physical Soc., May 22, 1908.)—A preliminary account is given of a method of studying diffusion which depends on suspending a flask of solution in a bath of water and noting the gradual decrease of weight as salt diffuses out and water diffuses in. The flask, of somewhat complex pattern, is suspended from a balance in a bath of distilled water surrounded with melting ice, and an electrical contact is arranged on the pointer of a Sartorius balance, so that when it "turns" a clock is automatically stopped, thus recording the time at which the contents of the flask had a definite weight; the clock is then reset with another weight on the pan and a fresh reading obtained. The most reliable values obtained for the diffusion coefficients were—

KNO_3 10 per cent.	0·848	$0·845 \times 10^{-5}$	KCl 20 per cent.	0·966	$0·978 \times 10^{-5}$
„ 5 „	0·870	0·871	„ 10 „	0·958	0·956

but no observations were available by other methods for comparison with these apparently very concordant results. T. M. L

929. *Diffusion of Chromium, Iron, and Aluminium Salts through Gelatine Jelly.* **H. R. Procter** and **D. J. Law.** (Soc. Chem. Ind., Journ. 28. pp. 297–299, March 31, 1909.)—When a solution of a chromium salt is placed on a jelly coloured pink with phenolphthalein, the acid produced by hydrolysis diffuses more rapidly than the salt, so that the advancing green layer is preceded by an area in which the colour of the jelly is bleached. Iron and aluminium salts behave in the same way, but in the latter case it is desirable to show up the basic salt of the inner zone by adding a trace of yellow logwood infusion with which alumina forms a violet lake. T. M. L.

930. *Electrical Conductivity of Solutions of Electrolytes in Water, Methyl and Ethyl Alcohols, Acetone and Binary Mixtures of these Solvents.* **S. V. Sěrkov.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 40. No. 9. pp. 899–427, 1908, and 41. No. 1. pp. 1–48 [Physical Part], 1909.)—The author has measured the conductivities of solutions of various concentrations of lithium chloride, bromide, iodide, and nitrate, ammonium thiocyanate, and sodium iodide and salicylate in the above-mentioned solvents. Solutions in mixtures of water and methyl alcohol all exhibit minima in their conductivity curves, these minima corresponding closely with the max. viscosities of the mixed solvents. The conductivities in mixtures of water and ethyl alcohol are, for all the electrolytes, much smaller than those calculated from the law of mixtures, owing to the high viscosity of the mixed solvent. With mixtures of methyl and ethyl alcohols, the conductivity curves are approximately rectilinear for all the electrolytes examined. For mixed solvents, of which one constituent is acetone, no parallelism exists between the conductivity and viscosity curves; when the mixture contains 75 per cent. of acetone, all the electrolytes exhibit a more or less well-marked maximum of conductivity. Sodium and lithium iodides, dissolved in a mixture of acetone and one of the other three solvents, give conductivity curves very similar to the corresponding fluidity curves; with lithium chloride and nitrate and sodium salicylate the conductivity and fluidity curves are totally dissimilar, whilst with lithium bromide and ammonium thiocyanate, intermediate behaviour is observed. The max. conductivity is not due to increase of the degree of dissociation, but is explained by the resolution of the compounds formed by the ions with the solvent. The lower the conductivity of an electrolyte in acetone at infinite dilution, the more marked is its maximum of conductivity. In a mixture of 75 per cent. of acetone with 25 per cent. of one of the alcohols, the conductivities at infinite dilution of all the lithium salts are approximately equal. T. H. P.

931. *Electrical Conductivity of Salts and Salt-Mixtures.* **A. Benrath.** (Zeitschr. Phys. Chem. 64. 6. pp. 693–706, Nov. 24, 1908. Inst. f. physikal. Chemie, Göttingen.)—The change of conductivity of silver, radium, and potassium nitrates is very abrupt at the melting-point, although the solid is still slightly conducting. The solid isomorphous mixtures of sodium and potassium nitrates, and of silver and sodium nitrates at temperatures a little below the melting-point, are considerably higher than those of the separate constituents. T. M. L.

932. *Viscosity and Conductivity of Aqueous Solutions.* **W. H. Green.** (Chem. Soc., Journ. 93. pp. 2023–2063, Dec., 1908.)—I. Solutions of Sucrose, Hydrogen Chloride, and Lithium Chloride. II. Mixtures of Solutions of Sucrose and Lithium Chloride. The Connection between Ionic Mobility and Fluidity. I. (1) The density of solid sucrose was found to be 1·5871 at 25°, giving a molecular volume 215·6 c.cm. The molecular volume in solution varies from 210·0 at great dilutions to 220·0 in a supersaturated syrup containing only a slight percentage of water. A 65 per cent. solution at 25° gives the same mol. vol. as that for the solid crystals. (2) A critical account is given of the existing values for the fluidity of water, and data are given for the viscosity of sugar solutions at 18° and 25° and of solutions of hydrogen chloride at 25° and of lithium chloride at 18° and 25°. The relationship between viscosity and concentration could not be expressed accurately by any of the existing formulæ, but the best approximation was given by $\eta/\eta_0 = A^{v/w}$, where η = viscosity, v = volume of solute, w = volume of solvent present per unit volume of solution, and A is a constant; even here varying discrepancies were observed according as the water or the solute was assumed to have a constant molecular volume. (3) Conductivity measurements were also made in the case of the two series of chloride solutions. II. Observations on the conductivity of solutions of hydrogen chloride and potassium chloride to which sugar had been added showed that the conductivity was not proportional to the fluidity, but to some power of the fluidity less than unity, *e.g.*, for HCl 0·55 and for KCl 0·70 gave the best result; an assumption of direct proportionality between fluidity and conductivity would imply an *increase* up to 400 per cent. in the mobility or in the ionisation. The later

experiments on the viscosity and conductivity of solutions containing sucrose and hydrogen or lithium chloride showed that (after extrapolating to infinite dilution) the molecular conductivity was almost proportional to the fluidity to the power of 0·7, thus confirming the conclusion arrived at from the earlier observations. The suggestion is made that the power $f^{\frac{2}{3}}$ may be of significance in some cases, whilst in other cases there may be a direct proportionality. T. M. L.

933. *Electrical Conductivity of Pure Hexane.* **G. Jaffé.** (Ann. d. Physik, 28. 2. pp. 326–370, Feb. 4, 1909. Habilitationsschrift, Leipzig.)—By careful purification a series of samples of hexane were obtained with the same limiting value for the conductivity, similar values being also given by heptane and by petroleum ether. The conductivity of the hexane in a brass cylinder of 8·8 cm. internal diam. was about 12·6 times as great as that of air under similar conditions, and corresponded to the production of 216 ions per c.cm. per sec. The hexane behaved like a dense gas in the following respects: (*a*) Two-thirds of the conductivity was caused by external radio-active radiation; (*b*) At potentials above 200 volts per cm. saturation occurred, the conduction becoming independent of the potential; (*c*) the conductivity was independent of the temperature, but (*d*) dependent on the material of the containing vessel. The conductivity was found to be independent of the direction of the current—a condition that was attributed to the action of soft β-rays. Experiments were also made on shielding the hexane from external radiations by means of lead, and the absorption coefficient was determined as 0·458 cm.$^{-1}$, agreeing with the coefficient for hard γ-rays. Certain anomalies which characterised the behaviour of petroleum ether when exposed to γ-radiation were removed by purification, the pure material reverting to the usual behaviour of a gas. The phenomenon of "Aufladung" (a lagging of resistance behind the changes of potential, so that on reversal an abnormally small resistance is at first observed) was also got rid of by purification. T. M. L.

934. *Validity of Ohm's Law for Electrolytes.* **A. Eucken.** (Phys. Zeitschr. 10. pp. 97–99, Feb. 1, 1909. Physikal.-chem. Inst., Berlin.)—The equations for the motion of ions, which account for a number of the properties of electrolytes (residual current *r*) cannot be brought into agreement with Ohm's Law, which loses its validity during the "stationary state," though it holds good so long as no marked changes have been produced in the concentration of the electrolyte, and therefore presumably for the bulk of the electrolyte away from the immediate neighbourhood of the electrodes. T. M. L.

935. *Nature of Precipitated Colloids.* **H. W. Foote.** (Amer. Chem. Soc., Journ. 30. pp. 1388–1394, Sept., 1908.)—The colloids studied were precipitated ferric, aluminium, and zirconium hydroxides. These, after heating to low temperatures (25° and 45°) in the air, were placed in a space saturated with aqueous vapour at the ordinary temperature. They then, as tested by weighing, either took up or gave out moisture according to their content of water. By trial, specimens were obtained which just ceased to give up water from themselves and just began to absorb moisture from the saturated atmosphere; these specimens were analysed as being saturated solutions (free from mechanically mixed water) of water in the hydroxides or oxides of the metals mentioned above. D. H. J.

936. *Influence of Temperature on the Valency between Metals and Oxygen.* **W. Biltz.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 4. pp. 293–317, 1908.)—The author has compared the experimental data relating to the decomposition of various metallic oxides at different temperatures, and has compared the experimental values with the Nernst formula—

$$\log p = Q/4{\cdot}57T + 1{\cdot}75 \log T + C,$$

good agreement being found. The following are the equilibrium temperatures for an oxygen pressure of 1 atmo. :—

	t.		*t.*
PtO_2/PtO	430° C.	Sb_2O_5/Sb_2O_4	450° C.
PtO/Pt	555°	Sb_2O_4/Sb_2O_3	1,060°
PdO_2/PdO	180°	Sb_2O_3/Sb	2,490°
PdO/Pd	875°	Co_3O_4/CoO	895°
CuO/Cu_2O	1,110°	CoO/Co	2,860°
Cu_2O/Cu	1,800°	Fe_2O_3/Fe_3O_4	1,970°
Il_2O_3/Il_2O	875°	Fe_3O_4/Fe	3,025°
Il_2O/Il	1,865°	MnO_2/Mn_2O_3	570°
PbO_2/Pb_3O_4	390°	Mn_2O_3/Mn_3O_4	1,090°
Pb_3O_4/PbO	615°	Mn_3O_4/MnO	2,500°
PbO/Pb	2,240°	MnO/Mn	4,050°

The above table shows that the more noble the metal the lower is the decomposition temperature of the lowest oxide. Further, for all metals, the higher the temperature the lower the valency. It is also found from the valency-temperature isobars that the slope of the curve is greater the higher the oxide, *i.e.*, the more the compound is saturated, and the region of existence is smaller. This means that the affinity of the metal for oxygen diminishes as the temperature is lowered and as the valency increases. Exceptions to the above are endothermic oxides, *e.g.*, Ir_2O_3, and lower oxides whose heat of formation is nearly zero, *e.g.*, WoO_2 and SnO. A. F.

937. *Specific Heat and Osmotic Pressure of Solutions.* **E. v. Biron.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 40. pp. 339–360 [Physical Part], 1908.)—The specific heat of a dissolved substance is expressed by the equation $C' = C(1 + m_0) - C_0 m_0$, where C and C_0 are the specific heats of the solution and solvent respectively, and m_0 the weight of solvent per unit weight of solute. The equation given by Bertrand [Thermodynamique, p. 109, 1887] becomes, in this case—

$$dC'/dV = T(d^2P/dT^2),$$

that is, the change of the specific heat of a dissolved substance with change of volume of the solution is proportional to the second differential coefficient of the osmotic pressure with respect to temperature. The following three cases are discussed and applied experimentally: (1) $dC'/dV = 0$, that is, the specific heat of the solute is constant, and does not change with the concentration of the solution; as d^2P/dT^2 is also zero, the osmotic pressure must, in this case, be either a linear function of, or independent of, the temperature, both of which relations are practically possible. (2) dC'/dV is greater than zero, that is, the specific heat of the solute increases with dilution of the solution. As, also, d^2P/dT^2 is greater than zero, the osmotic pressure is not a linear function of, but increases more rapidly than, the temperature. There are many solutions exhibiting this property, notably aqueous solutions of

organic hydroxylic compounds. (3) dC'/dV is less than zero, that is, the specific heat of the solute diminishes with dilution of the solution, and the osmotic pressure consequently increases in less than linear relation with the temperature. This behaviour is characteristic of dilute solutions of electrolytes, and stands in intimate relation to their electrical conductivity.
T. H. P.

938. *Osmotic Studies.* **L. Kahlenberg.** (Journ. Phys. Chem. 13. pp. 93–113, Feb., 1909.)—The present paper is a reply to the criticisms directed by Cohen and Commelin [Abstract No. 336 (1909)] against the measurements of osmotic pressure previously communicated by the author [Abstract No. 1142 (1906)]. With regard, first of all, to the general part of Cohen and Commelin's paper, the author adheres to the position which he had previously held, and while recognising the value of the constants of freezing-point depression, elevation of the boiling-point, &c., denies that they are of necessity related to actual osmotic pressures, as measured by means of so-called semi-permeable membranes, in any such way as required by the theory of van't Hoff. According to the author, there is really no such thing as a semi-permeable membrane, and osmosis goes on in both directions. Only when the osmosis in one direction by far outweighs that in the other, do we have a so-called semi-permeable membrane. "A clear recognition of this robs direct osmotic pressure measurements of practically all the importance that has hitherto been accorded them as a foundation for a theory of solutions." With regard to his experimental work, and that of Cohen and Commelin, the author points out that neither his own results nor those of Cohen and Commelin lead him to alter his view that the gas laws do not hold, in any case for pyridine solutions of silver nitrate, &c. Moreover, the adverse criticism of Cohen and Commelin of the importance ascribed by the author to stirring the solution in the osmometer, is pointed out as being unjustified, and the author complains that Cohen and Commelin have compared experiments which were not comparable. He also replies to the criticism of Cohen and Commelin with regard to temperature effects, and insists that the conclusion that the low osmotic pressures produced at low temperatures were due to the osmometer acting as a thermometer, is wrong, as he was careful to avoid such effects. As a result, therefore, the author sees no reason for retreating from his former position; and he adversely criticises the apparatus used by Cohen and Commelin in their experiments, and, moreover, points out that their results are additional evidence demonstrating that the gas laws do not hold for osmotic pressures in the cases investigated. A. F.

939. *Osmotic Pressure of Cane-sugar Solutions at* 25°. **H. N. Morse** and **W. W. Holland.** (Amer. Chem. Journ. 41. pp. 1–19, Jan., 1909.)—The earlier measurements at 25° have been discarded, as later improvements have resulted in a great increase in accuracy; fresh values are now given for the osmotic pressures of solutions from 0·1 to 1·0 normal. The most interesting point now brought forward is the extreme closeness with which the temperature-coefficient of the osmotic pressure of cane-sugar solutions agrees with that of gas pressure. This is well shown by the following values, which

0°	[1·074]	15°	1·064
4° to 5°	[1·065]	25°	1·064
10°	1·061		

show the ratio of osmotic pressure to calculated gas pressure for five different temperatures; this is substantially constant from 5° to 25°, and it is not unlikely that a redetermination of the values at 0° and 5° which is now in progress will lead to still closer agreement. T. M. L.

940. *Osmotic Experiments on the Alkali Haloids.* **F. Wiemers.** (Ann. d. Physik, 27. 5. pp. 1081–1097, Dec. 15, 1908.)—The author reverts to the type of osmotic experiments, prevalent before the discovery of semi-permeable membranes in 1867, in which an osmotic flow took place in both directions through a permeable membrane, *e.g.*, salt outwards from a solution into pure water and water inwards to the solution. Values were determined for the endosmotic equivalents—*i.e.*, the ratios of the water entering to the salt escaping, for different salts and under different conditions. For saturated solutions values found were—

NaCl.........	3·54	3·26	KCl	2·18	2·09
NaBr	1·34	—	KBr.........	1·10	0·99
NaI	1·09	1·16	KI	0·95	0·97
RbCl.........	1·95	—	RbI	0·55	—
RbBr	0·78	—	LiBr	1·77	—

showing a decrease in the series Na, K, Rb, and in the series Cl, Br, I. Although the flow was more rapid at higher temperatures, the equivalents were found to be independent of the temperature, but to increase somewhat with increasing concentration of the solution. T. M. L.

941. *Plaitpoint Temperatures of the System: Water-Phenol.* **A. Keesing.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 394–397, Dec. 23, 1908.) —Water and phenol give a mixture of max. vapour pressure, and should therefore show a minimum critical temperature. This was determined by heating them in a sealed tube of silica glass surrounded with a hot wire wrapped in asbestos, and a vapour jacket silvered (with the exception of two strips) to prevent radiation. The tube was heated by means of pure benzidine boiling (at about 400°) under an atmosphere of nitrogen, the temperature being varied by altering the pressure of the nitrogen. The following results were obtained:—

Proportion of phenol	0	0·06	0·1	0·2	0·35	0·5	1·0
Meniscus disappeared	365·0	359·0	357·0	364·2	379·4	394·8	[419·2]
„ reappeared	363·9	358·5	356·0	363·0	378·0	393·8	

There is thus a minimum at about 10 per cent. phenol and temperature 356° C.

T. M. L.

942. *Simple Relationship between Density and Degree of Dissociation of Aqueous Salt Solutions.* **A. Heydweiller.** (Deutsch. Phys. Gesell., Verh. 11. 2. pp. 37–44, Jan. 30, 1909. Physikal. Inst., Rostock, Dec., 1908.)—A linear relationship frequently exists between the increment of density per equivalent of salt and the equivalent conductivity, so that—

$$(s-1)/m = A\Lambda + B,$$

or (taking different value for the constants)—

$$(s-1)/m = Ai + B(1-i).$$

This formula, with suitable values for A and B, and Kohlrausch's value for i, gives excellent results when used to calculate $(s-1)/m$. In only 16 out of 67 electrolytes examined were serious deviations observed, and even these could be attributed in some cases, *e.g.*, the cadmium salts, to the formation of complex ions; other exceptions were the sulphates of Ni, Fe, Mn, Zn, Mg, calcium chromate, lead nitrate, potassium oxalate, phosphoric, sulphuric, and acetic acids, and *concentrated* solutions of nitric acid, sodium hydroxide, and calcium nitrate. For non-electrolytes such as sugar $(s-1)/m$ is almost constant $(i=0)$; for electrolytes the constant A, which deals with the ionised part of the salt, shows the characteristics of an additive property, the differences for Na and Li being almost independent of the anion, and so forth. T. M. L.

943. *Kinetics of the Dissociation Equilibrium and of the Velocity of Reaction.* **F. Krüger.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 4. pp. 318–336, 1908.)—The author has developed a formula for the dissociation equilibrium $AB = A + B$, on the basis of the following assumptions: (1) The atom B possesses complete freedom of motion within the sphere of action of A. (2) The velocities of B in the molecules AB follow the Maxwell Law of Distribution. (3) The atom B can escape from the sphere of action of A only when its velocity exceeds a certain minimum value. (4) Every collision of the atoms A and B are to be regarded as giving rise to a compound. A temperature-coefficient equation is also obtained. A. F.

944. *Heat of Ionisation and Ionisation Constants of Water.* **A. Heydweiller.** (Ann. d. Physik, 28. 3. pp. 503–512, March 2, 1909.)—In 1894, in conjunction with Kohlrausch (Ann. d. Physik, 53. p. 209), the author determined the conductivity of pure water, and calculated the heat of ionisation and the ionisation constants of water. In consequence of recent investigations on conductivity and heats of neutralisation [compare Wörmann, Abstract No. 803 (1906); Noyes, Abstract No. 1523 (1908); Lundén, Journ. Chim. Phys. 5. p. 574, 1907] the author recalculates his previous results. It is found that the heat of ionisation $s = (14617 - 48{\cdot}5\,t)$ gm.-cals. at 15°, and that the conductivity $K \times 10^{14}$ of pure water in mercury units is given by the expression—

$$\log[K - 0{\cdot}0056 - 0{\cdot}000118(t-18)] = 30{\cdot}2339 - 3047{\cdot}3/T - 12{\cdot}125 \log T$$
$$+ \log(322{\cdot}4 + 7{\cdot}80t + 0{\cdot}0085t^2).$$

The degree of dissociation is found to be 12·2 per cent. greater, and the ionisation constant, $K_w = a^2/(1-a)$ or $0{\cdot}59 \times 10^{-14}$ at 18°, about 25 per cent. greater than the values given by Noyes (*loc. cit.*). T. H. P.

945. *The Oxide Theory of the Oxygen Electrode.* III. **R. Lorenz** and **E. Lauber.** (Zeitschr. Elektrochem. 15. pp. 206–212, April 1, 1909. From the Laborat. f. phys. Chemie u. Elektrochemie des eidgen. Polytechnikums, Zürich.)—The authors have studied the polarisation discharge curves at platinum anodes. With polished Pt the curve shows a series of short curves with sharp breaks, but with platinised electrodes the halting-points become indistinct, and the "breaks" are rounded. When too small a kathode capacity is employed the curves lie parallel, the position of the curves depending on the duration of charge and on the intensity of the charging current. [See Abstract Nos. 175, 745 (1909).] A. F.

946. *Study of Polarisation by means of the Dolezalek Electrometer.* **A. F. Ewan.** (Roy. Soc. Edinburgh, Proc. 29. pp. 165–174, 1908–1909.)—In order to investigate whether there is a variation of the e.m.f. of polarisation of a cell with the p.d. between the electrodes, a current was passed through two cells of very different resistances, but otherwise exactly similar, arranged in series; their electrodes consequently differed considerably in potential. The difference of potential between the electrodes and the liquid in the cells immediately behind the electrodes was then measured at observed times, using a Dolezalek electrometer, and the corresponding curves plotted. The conclusion arrived at is that there is no evidence of variation of the e.m.f. of polarisation with the difference of potential of the electrodes, any observed variation being largely, and possibly wholly, due to differences in the areas of the electrodes. Measurements of the variation of polarisation with time during the flow of current were also made, in order to test Wiedeburg's formula for the relation between these variables. It was found that throughout a range which could be fairly tested by these experiments the agreement is fairly good. Further experiments are to be carried out, with more satisfactory precautions against sources of error. T. S. P.

947. *Absolute Null-point of Potential.* **H. Freundlich** and **E. Mäkelt.** (Zeitschr. Elektrochem. 15. pp. 161–165, March 15, 1909. Physikal.-chem. Inst., Leipzig.)—It is well known that the null-point of potential as determined by Ostwald and Palmaer deviates considerably from that obtained by Billiter. In order to clear up the discrepancies the authors have repeated some of Billiter's experiments, in particular those in which the position of the null-point was determined by observing the sign of the charge on silver particles falling through an electrolyte between silver electrodes. It was found that the measurements were reproducible, the sign of the charge depending on the composition of the electrolyte. It was shown, however, in contradiction to Billiter, that the charge does not simply depend on the concentration of the Ag-ions, but also on the presence of other ions, especially hydrions and hydroxylions. The current which results is, therefore, not caused by the formation of a Helmholtz-Nernst double layer, but by the friction of the particles against the electrolyte; this interpretation is in good agreement with the results of Perrin on electro-endosmosis. No conclusions can therefore be drawn with respect to the position of the null-point of potential. The experiments in which a solution flows over mercury were also repeated. With a large velocity of flow and solutions of mercury silver cyanide of different concentrations, a change in the sign of the charge was observed at $-0{\cdot}5$ volt, which agrees approximately with Ostwald's null-point. With lesser velocities, however, the results were in approximate agreement with those of Billiter, but they could not be reproduced with certainty. In this case, also, the phenomena were conditioned by frictional electrical processes.

T. S. P.

948. *Calculation of Ionic Hydration from the Transport-numbers and Electromotive Forces.* **B. Reinhold.** (Zeitschr. Elektrochem. 14. pp. 765–766, Nov. 20, 1908.)—The transport-number determined experimentally by Hittorf only gives a measure of the relation of the velocities of migration of the ions when the current causes only transport of the ions, the undissociated molecules of the electrolyte and also the molecules of the solvent remaining fixed in their places. If hydration occurs, the difference between the molecules attached to an anion and to a kathion can be calculated from the transport-number obtained. Calculation based on these considerations leads to a formula similar to that obtained by Lewis [Abstract No. 168 (1909)].

T. H. P.

949. *Migration Constants of Dilute Solutions of Hydrochloric Acid.* **C. Chittock.** (Cambridge Phil. Soc., Proc. 15. pp. 55–68, Feb. 23, 1909.)—The following values were obtained for the migration constant of HCl in dilute solutions (n = gm.-equivalents HCl per 1,000 gm. of solution)—

n = 0·1120 0·0847 0·0885 0·0547 0·0469 0·465
p = 0·171 0·194 0·192 0·213 0·256 0·275

the value for more concentrated solutions being 0·167. The change in the value of the migration "constant" is much greater than that observed by Whetham and Paine in dilute solutions of sulphuric acid; it is too great to be accounted for by a decrease in the mobility of the hydrogen ion, as is shown by calculation in one of the above cases, but may be explained on the view that ammonia is present as an impurity in the water. Owing to its slight ionisation it would only impart a small conductivity to the water, but might exert a much more marked effect in reducing the mobility of the kathion and the conductivity of the acid in the more dilute solutions. T. M. L.

950. *Electrolytic Precipitation of Cuprous Oxide.* **D. Miller.** (Journ. Phys. Chem. 13. pp. 256–261, March, 1909.)—A hot solution of sodium chloride was electrolysed between copper electrodes, and the cuprous oxide thus formed examined under the microscope, the colour as well as the size of the particles being noted. The colour depends on the composition and size of the particles, it being darker the larger the particles. The composition varies from cuprous oxide (red) to cuprous hydroxide (yellow). Variation of temperature between 60° and 100° C. showed that the higher the temperature the deeper the colour of the precipitate. Increase in the current density caused the particles to become smaller and lighter in colour. The greater the concentration of the electrolyte the lighter becomes the precipitate, but the variation in the precipitate is not so marked as when the temperature or current density is changed. T. S. P.

951. *Calorimetric Determination of the Heat Evolution at Electrodes.* **P. Bräuer.** (Zeitschr. Phys. Chem. 65. 1. pp. 111–120, Dec. 8, 1908.)—From the temperature-coefficient of e.m.f. of a copper electrode Ostwald has calculated that when two faradays pass from a copper electrode at 20° C. into a normal solution of copper sulphate there is an evolution of heat of 10,200 gm.-cals. The author has now measured directly the heat evolution and finds it equal to 8,930 gm.-cals. Part of the deviation from the Ostwald figure is due to the latter having used the value of the temperature-coefficient determined by Bouty. This the author finds to be 10 per cent. too high. Using the value as determined by the author the calculated heat evolution is 9,320 cals. A. F.

REFERENCES.

952. *Contribution to the Testing of Beer's Absorption Law.* **F. Stumpf.** (Phys. Zeitschr. 10. pp. 29–32, Jan. 1, 1909.)—The author has subjected Beer's absorption law to the test by means of solution in benzene of amidoazobenzene, and finds the law to hold within experimental error. Tests carried out with alcoholic solutions did not give the same agreement—a fact which is attributed by the author to electrolytic dissociations. A. F.

953. *Absorption of Complex Copper Compounds in the Violet and Ultra-violet Regions.* **A. Byk.** (Zeitschr. Phys. Chem. 61. 1. pp. 1–75, Oct. 29, 1907. From the Laborat. f. Photochemie u. Spektralanalyse an d. techn. Hochschule, Berlin.)

954. *Thermodynamical and Electrochemical Calculation of Photochemical Reactions.* **A. Byk.** (Zeitschr. Phys. Chem. 62. 4. pp. 454–492, April 10, 1908.)—A theoretical paper.

955. *Tate's Law.* **T. Lohnstein.** (Zeitschr. Phys. Chem. 64. 6. pp. 686–692, Nov. 24, 1908.)—The data given by Morgan and Stevenson [Abstract No. 1519 (1908)] are discussed, and are regarded as agreeing better with the author's formula for the weight of a falling drop than with the formula of Tate. T. M. L.

956. *Solid Solution in the Dissociation of Copper Oxide.* **L. Wöhler** and **W. Frey.** (Zeitschr. Elektrochem. 15. pp. 34–38, Jan. 15, 1909. Communication from the Chem. Inst. d. techn. Hochschule, Karlsruhe.)—Cupric oxide dissociates into cuprous oxide and oxygen and not directly into metal and oxygen; in other respects the investigation is parallel to that of the oxides of iridium [Abstract No. 1340 (1908)]. T. M. L.

957. *Mysteries of Metals.* **J. O. Arnold.** (Engineering, 87. pp. 145–148, Jan. 29, and pp. 170–173, Feb. 5, 1909. Lecture delivered at the Royal Institution, Jan. 21 and 28, 1909.)—In the course of this lecture curves showing results of cutting efficiency tests of a high-speed steel and a carbon tool-steel hardened from increasing temperatures are given. F. R.

958. *The Air-furnace Process.* **H. M. Howe** and **E. Touceda.** (Amer. Inst. Mining Engin., Bull. 27. pp. 317–326, March, 1909.)—Gives the composition of the iron and slag at different stages in the air-furnace process of preparing "hard metal" or white cast iron for conversion into malleable cast iron by annealing. Discusses the removal of silicon as affected by the silicon-content and by the ratio of the carbon-content to the silicon-content, and compares results with open-hearth processes. C. O. B.

959. *Present Status of the Solvate Theory.* **H. C. Jones.** (Amer. Chem. Journ. 41. pp. 19–57, Jan., 1909.)—A summary of the work done during the last ten years by Jones and his colleagues, which will be of value to those who have not read the original communications. Only a few incidental references are made to the work of other experimenters. T. M. L.

960. *Equilibrium between Liquid and Solid Phases in the System: $NaCl + H_2O$.* **C. Matignon.** (Comptes Rendus, 148. pp. 550–553, March 1, 1909.)—The eutectic point for ice and salt was found to be —21·3° C. at 30·7 per cent. of salt. A complete diagram is also given for the crystallisation from the liquid of ice and of the hydrate $NaCl, 2H_2O$ which separates below 0° C. T. M. L.

961. *Electrolytic Reduction of a Nitro-compound of Pyrazolon.* **E. Remy** [with **G. Kümmell**]. (Zeitschr. Elektrochem. 15. p. 254, April 15, 1909. Physikochem. Laborat. d. Univ., Rostock, Feb., 1909.)—On submitting Nitro-1-Phenyl-3-Pyrazolon to electrolytic reduction in acid solution the amine is produced, giving an 86 per cent. yield. The stages of reduction are the same as with aromatic nitro-compounds.

T. S. P.